12-1-1979

A Multicountry Econometric Model

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COWLES FOUNDATION DISCUSSION PAPER NO. 541

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December 4, 1979

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I. Introduction

A multicountry econometric model is presented in this paper. The theoretical basis of the model is discussed in Fair (1979a, 1979b), and the present paper is an empirical extension of this work. Quarterly data have been collected or constructed for 64 countries, and the model contains estimated equations for 42 countries. The basic estimation period is 1958I-1978IV (84 observations). For equations that are relevant only when exchange rates are flexible, the basic estimation period is 1972II-1978IV (27 observations). Most of the equations have been estimated by two stage least squares.

The model differs from previous models in a number of ways. First, the model accounts for exchange rate, interest rate, and price linkages among countries as well as the usual trade linkages. Previous multi-country econometric models have been primarily trade linkage models. The LINK model (Ball 1973), for example, is of this kind, although some recent work has been done on making capital movements endogenous in the model.[1]

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*The research described in this paper was financed by grant SOC77-03274 from the National Science Foundation.

[1]See Hickman (1974, p. 203) for a discussion of this. See also Berner et al. (1976) for discussion of a five-country econometric model in which capital flows are endogenous.

Second, the theory upon which the model is based differs somewhat from previous theories. The theoretical model in Fair (1979a) is one in which stock and flow effects are completely integrated. There is no natural distinction in this model between stock-market and flow-market determination of the exchange rate, a distinction that is important in recent discussions of the monetary approach to the balance of payments.[2] The theoretical model also allows for the possibility of price linkages among countries, something which has generally been missing from previous theoretical work.

Third, the number of countries in the model is larger than usual, and the data are all quarterly. Considerable work has gone into the construction of quarterly data bases for all the countries. Some of the quarterly data had to be interpolated from annual data, and a few data points had to be guessed. The collection and construction of the data bases are discussed in the Appendix.

Finally, there is an important difference between the approach taken in this study and an approach like that of Project LINK. I myself have estimated small models for each country and then linked them together, rather than, as Project LINK has done, take models developed by others and link them together. The advantage of the LINK approach is that larger models for each country can be used. It is clearly not feasible for one person to construct medium- or large-scale models for each country. The advantage of the present approach, on the other hand, is that the person constructing the individual models knows from the beginning that they are to be linked together, and this may lead to

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[2] See, for example, Frenkel and Johnson (1976), Dornbusch (1976), Frenkel and Rodriguez (1975), and Kouri (1976).

better specification of the linkages. It is unlikely, for example, that the specification of the exchange rate and interest rate linkages in the present model would develop from the LINK approach. Whether this possible gain in the linkage specification outweighs the loss of having to deal with small models of each country is, of course, an open question.

The theoretical basis of the model is reviewed in Section II. Because of data limitations, not all versions of the theoretical model in Fair (1979a) can be estimated, and the primary purpose of Section II is to present the version of the theoretical model that the econometric model most closely approximates. The econometric model is presented and discussed in Section III. The predictive accuracy of the model is then examined in Section IV, and the properties of the model are discussed in Section V. Section VI contains a brief conclusion.

II. The Theoretical Basis of the Model

The transition from the theoretical model in Fair (1979a) to a model that can be estimated depends on the data that are available. In the present case there are four main limitations of the data. First, very little bilateral financial data are available. Second, adequate data on the flow of funds among sectors within a country are only available for the United States. Third, data on government taxes and transfers are not very good or non-existent for many countries. Fourth, good employment data are not available for many countries. The lack of bilateral financial data means that only two special cases of the theoretical model can be considered: zero and perfect capital mobility. These two cases do not require the bilateral data. Although in principle only these two cases can be considered in the empirical work, an attempt has been made in this study to approximate the in between case. This approximation is discussed below. The second and third data limitations are most easily handled by aggregating the four sectors in the theoretical model (household, firm, financial, and government) into one sector. The lack of good employment data can be handled by merely dropping the labor markets from the model.

An outline of the theoretical model that was used to guide the specification of the econometric model is presented in Table 1. The model in this table is a version of the basic model in Fair (1979a), aggregated and simplified in such a way as to meet the requirements of the data. The following is a brief discussion of this version. Capital letters denote variables for country 1; lower case letters denote variables for country 2; and an asterisk (*) on a variable denotes the other country's holdings or purchase of the variable. Each country specializes in the production of one good (X,x), has its own money (M,m), and has its own bond (B,b). The bonds are one-period securities. Negative values of B and b denote liabilities. The interest rate on B is R and on b is r. The price of X is P and of x is p. e is the price of country 2's currency in terms of country 1's currency, and F is the (one-period) forward price of country 2's currency. Each country holds a positive amount of the international reserve (Q,q), which is denominated in the currency of country 1. In some cases it is necessary to distinguish between the private and government sectors in a country, and subscripts p and g are used for this.[3]

[3] The notation in Table 1 is the same as the notation in Fair (1979a), aside from the change or elimination of subscripts due to the aggregation of the sectors, except that F rather than e' now denotes the forward price of country 2's currency. Also, Q and q are now assumed to be dominated in the currency of country 1, whereas before they were assumed to have a price of 1.0 always.

TABLE 1. An Outline of the Theoretical Model

<u>All Cases</u>

Country 1:

(1) $X_p = f_1(\overset{-}{P}, \overset{+}{e \cdot p}, \overset{-}{R}, \overset{+}{X}, \overset{+}{B_{-1}}, \overset{+}{e \cdot b^*_{-1}})$	[demand for the good of country 1 by country 1's private sector]
(2) $x^* = f_2(\overset{+}{P}, \overset{-}{e \cdot p}, \overset{-}{R}, \overset{+}{X}, \overset{+}{B_{-1}}, \overset{+}{e \cdot b^*_{-1}})$	[demand for the good of country 2 by country 1]
(3) $P = f_3(\overset{+}{e \cdot p}, \overset{+}{R}, \overset{+}{X})$	[price of the good of country 1]
(4) $M_p = f_4(\overset{-}{R}, \overset{+}{P \cdot X})$	[demand for the money of country 1 by country 1's private sector]
(5) $S = P \cdot X^* - e \cdot p \cdot x^* + R \cdot B + e \cdot r \cdot b^*$	[saving of country 1]
(6) $0 = S - \Delta B - e \cdot \Delta b^* - \Delta Q$	[budget constraint of country 1]
(7) $X = X_p + X_g + X^*$	[total demand for the good of country 1]
(8) $M_g = M_p$	[equilibrium condition for the money market of country 1]
(9) $0 = B + B^*$	[equilibrium condition for the bond market of country 1]

Country 2:

(10) $x_p = f_{10}(\overset{-}{p}, \overset{+}{P/e}, \overset{-}{r}, \overset{+}{x}, \overset{+}{b_{-1}}, \overset{+}{B^*_{-1}/e})$	[demand for the good of country 2 by country 2's private sector]
(11) $X^* = f_{11}(\overset{+}{p}, \overset{-}{P/e}, \overset{-}{r}, \overset{+}{x}, \overset{+}{b_{-1}}, \overset{+}{B^*_{-1}/e})$	[demand for the good of country 1 by country 2]
(12) $p = f_{12}(\overset{+}{P/e}, \overset{+}{r}, \overset{+}{x})$	[price of the good of country 2]
(13) $m_p = f_{13}(\overset{-}{r}, \overset{+}{p \cdot x})$	[demand for the money of country 2 by country 2's private sector]
(14) $s = p \cdot x^* - \frac{1}{e} P \cdot X^* + r \cdot b + \frac{1}{e} R \cdot B^*$	[saving of country 2]
(15) $0 = s - \Delta b - \frac{1}{e} \Delta B^* - \frac{1}{e} \Delta q$	[budget constraint of country 2]
(16) $x = x_p + x_g + x^*$	[total demand for the good of country 2]
(17) $m_g = m_p$	[equilibrium condition for the money market of country 2]
(18) $0 = b + b^*$	[equilibrium condition for the bond market of country 2]
(19) $0 = \Delta Q + \Delta q$	[no change in total world reserves]

Note: One equation from (5), (6), (9), (14), (15), (18), and (19) is redundant.

<u>Other Possible Equations</u>

(20) $R = f_{20}(\overset{+}{\dot{P}}, \overset{+}{\dot{M}_p}, \overset{+}{X})$	[interest-rate reaction function of the monetary authorities of country 1]
(21) $r = f_{21}(\overset{+}{\dot{p}}, \overset{+}{\dot{m}_p}, \overset{+}{x})$	[interest-rate reaction function of the monetary authorities of country 2]
(22) $F = f_{22}(\overset{+}{p/P}, \overset{+}{x/X})$	[forward price of country 2's currency]
(23) $R = (e/F)(1+r) - 1$	[arbitrage condition if perfect capital mobility]
(24) $e = f_{24}(\ldots)$	[exchange-rate reaction function of one of the governments]

Note: The signs above the explanatory variables indicate the expected signs of the effects.

A $\cdot$ above a variable denotes percentage change.

The decisions of the individual agents in the theoretical model are assumed to be derived from the solutions of multiperiod maximization problems: households maximize utility and firms maximize profits. The variables that explain the decision variables are the variables that affect these solutions. For the version of the model in Table 1 this feature is somewhat blurred because of the aggregation of firms and households into one sector. The demand equations can, however, be considered to be consistent with the assumption of maximizing behavior on the part of households, and the price equation can be considered to be consistent with the assumption of maximizing behavior on the part of firms.[4] The demands for the two goods for each country (equations (1), (2), (10), and (11)) are functions of the two prices, the interest rate, income as measured by X or x, and wealth as measured by the initial stocks of bonds. An increase in income or wealth causes both demands to increase, and an increase in the interest rate causes both demands to decrease. An increase in the price of one good relative to the other causes the demand for the one good to fall relative to the demand for the other. The price of each good, which is assumed to be set by the firm sector in the country, is a function of the price of the other good, the interest rate, and demand (equations (3) and (12)). An increase in any of these three variables causes the price to rise.

Another important feature of the theoretical model is the accounting for all flows of funds among the sectors, and this feature has been retained in the version of the model in Table 1. The flows of funds

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[4]This emphasis on maximizing behavior goes back to my earlier work [Fair (1974, 1976)] on developing a macroeconomic model for a single country. The inclusion of the interest rate in the price equation in Table 1 is somewhat unusual, but, as shown in Fair (1974), the interest rate does affect a firm's optimal price decision.

between the two countries are accounted for (the saving equations (5) and (14)), and both countries' budget constraints are accounted for (equations (6) and (15)). The saving of each country is equal to export and interest revenue less import and interest costs, and any non-zero level of saving must result in the change in holdings of one of the two bonds or of the international reserve.

The demand for money for each country is a function of the interest rate and nominal income as measured by $P \cdot X$ or $p \cdot x$ (equations (4) and (13)).[5] The remaining equations in the basic model are equilibrium conditions for the goods, money, bond, and reserve markets (equations (7), (8), (9), (16), (17), (18), and (19)). As noted in Table 1, one of the first 19 equations is redundant.

Equations (20)-(24) are other equations that were considered in Fair (1979a). They are possible equations to add to the basic model, although not all combinations result in a closed model. There are, first of all, a number of options for the determination of the interest rates in the model, one of which is the postulation of reaction functions of the monetary authorities (equations (20) and (21)). In the econometric work reaction functions have been estimated for a number of countries. These are equations in which the monetary authorities are estimated to "lean against the wind." As inflation, real output, or the growth of the money supply increases, the monetary authorities are estimated to allow short term interest rates to rise.[6]

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[5]It is assumed in Table 1 that the countries do not hold each other's money. This is contrary to the treatment in Fair (1979a), where demand for money functions for the other country's money were postulated.

[6]A reaction function of this type is estimated in Fair (1978) for the U.S. Federal Reserve. As will be discussed, this equation is part of the present model.

It is important to note that for the model in Table 1 at least one interest rate reaction function must be postulated in order to close the model. Because the government and private sectors have been aggregated into one sector in this version, there is no government security variable that can be treated as a policy variable of the monetary authorities. Therefore, it is not possible in this version, unlike in the disaggregated version, to take government securities outstanding to be exogenous and let the interest rate be implicitly determined.[7] With respect to the possible effect of the demand for money on the interest rate, note that the demand for money does affect the interest rate in the model in Table 1 through the reaction functions. The growth of the money supply is one of the variables that affects the interest rate decision of the monetary authorities.

Equation (22) determines the forward price of country 2's currency. The arguments of this equation were left unspecified in the theoretical model. One would expect them to be variables that affect people's expectations of the future spot price of the currency. As will be discussed in Section III, these variables were found in the econometric work to include the price level of the country relative to the price level of the base country and the output of the country relative to the output of the base country. (The base country in the model is the U.S.) The estimates of equation (22) are an important part of the model, and much more will be said about these later. Equations (23) and (24) will also be discussed later. Equation (23) is the arbitrage condition when there is perfect capital mobility, and equation (24) is an exchange rate reaction function of one of the governments. Equation (24) has been estimated

[7] See Fair (1978) for a discussion of the various ways in which the interest rate can be determined in a model with both a government and a private sector.

for a few of the countries.

There are many cases that can be considered within the basic framework of the theoretical model in Table 1. There are three options for the determination of each of the two interest rates (fixed, managed,[8] and floating); there are three options for the determination of the exchange rate (fixed, managed, and floating); and there are three assumptions about capital mobility that can be made (zero, imperfect, and perfect). For present purposes it will be useful to limit the discussion to those cases in which R is always managed and capital mobility is either zero or perfect. These cases are presented in Table 2.

Consider the first set of cases in Table 2: R managed and zero capital mobility. Under the assumption of zero capital mobility, B^* and b^* are exogenous. The model for this set of cases consists of equations (1)-(19), (20), possibly (21), and possibly (24).[9] One of the equations is redundant, and it will be convenient to drop (19). Not counting the government spending variables, X_g and x_g, which are assumed to be exogenous, and B^* and b^*, there are 21 variables in the model. A variable that appears naturally on the left-hand-side of an equation can be matched to that equation.[10] This leaves four equations not used: (6), (9), (15), and (18). q can be matched to

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[8]By "managed" in this paper is meant determined according to a reaction function.

[9]When there is zero capital mobility (i.e., no equation (23)), the forward price of the exchange rate has no affect on anything in the model, and so equation (22) need not be considered.

[10]Since the model is simultaneous, the following matching of variables and equations is not meant to imply that the variable is solely determined by the equation it is matched to. The matching is merely meant to provide some insight into the various cases that are possible in the model.

TABLE 2. Some Cases in the Theoretical Model

I. R managed (equation (20)) and zero capital mobility (B^* and b^* exogenous.

Interest Rate of Country 1		Exchange Rate: Fixed (e exog.)	Exchange Rate: Managed (e by eq. (24))	Exchange Rate: Floating (e endo.)
	Fixed (r exog.)	Q endo.	Q endo.	Q exog.
	Managed (r by eq. (21))	Q endo.	Q endo.	Q exog.
	Floating (r endo.)	Q exog.	Q exog.	X

II. R managed (equation (20)); forward rate determined by equation (22); and perfect capital mobility (equation (23)). When there is perfect capital mobility, the model is underidentified with respect to B^* , b^* , and Q . Two of these (say, B^* and b^*) must be taken to be exogenous.

Interest Rate of Country 2		Exchange Rate: Fixed (e exog.)	Exchange Rate: Managed (e by eq. (24))	Exchange Rate: Floating (e endo.)
	Fixed (r exog.)	X	X	Q endo.
	Managed (r by eq. (21))	X	X	Q endo.
	Floating (r endo.)	Q endo.	Q endo.	Q exog.

(15), B to (9), and b to (18). Then to equation (6) can be matched Q, r, or e, depending on the assumptions about r and e. If both r and e are fixed or managed, the Q is endogenous and matched to (6). If either r or e (but not both) is floating, then Q is exogenous and the floating variable is matched to (6). If both r and e are floating, the model is not closed under the above assumptions.

Consider now the second set of cases in Table 2: R managed and perfect capital mobility. When there is perfect capital mobility, the model is underidentified with respect to B^*, b^*, and Q, and two of these must be taken to be exogenous. Let these be B^* and b^*. Then the same matching can be done as before except that the cases in which the model is not closed are now different. Given the forward rate as determined by (22) and R as determined by (20), the arbitrage condition (23) determines either e or r. Therefore, it is not possible for both e and r to be fixed or managed. If one of these is fixed or managed, then the other is matched to (23). In this case Q is exogenous and matched to (6). If both e and r are floating, then one is matched to (23) and the other to (6). Q in this case is exogenous.

Another way of looking at Table 2 is to note that if there is zero capital mobility, then country 2 can manage both its interest rate and the exchange rate, whereas if there is perfect capital mobility, it can manage only one. The instrument by which it achieves the desired value of one of these variables is its holdings of the international reserve. If it wants to manage its reserve holdings (Q exogenous), then under zero capital mobility it can also manage r or e (but not both), whereas under perfect capital mobility it can manage neither.

For empirical work an advantage of the cases in Table 2 is that

B^* and b^* are exogenous. This means that little is lost from not collecting data on B^* and b^* (i.e., from not collecting bilateral financial data). For the in between case of imperfect capital mobility, on the other hand, equations explaining B^* and b^* are needed, and so obviously data on these variables are needed. The in between case is, of course, likely to be the most realistic, and as mentioned above, an attempt was made in this study to approximate this case. This approximation will now be described. It should be kept in mind in the following discussion that the U.S. is assumed to be the "leading" country with respect to the determination of interest rates. In particular, the reaction function that explains the U.S. interest rate was estimated over the entire sample period, something which, as will now be seen, was not done for the other countries.

Consider first the fixed exchange rate period. If there were zero capital mobility, then one could estimate interest rate reaction functions for each country: each country's interest rate would be determined by its own reaction function. If, on the other hand, there were perfect capital mobility, then no reaction functions could be estimated (aside from the one for the U.S.). In this case r for each country would be determined by the arbitrage condition (23). If the forward and spot exchange rates are always equal to each other in the fixed exchange rate period, something which is approximately true, then each country's interest rate would always equal the U.S. rate. The approximation that was used in this study was to estimate reaction functions for each country, but to add to these equations the U.S. interest rate as an explanatory variable. (In terms of the model in Table 1, R is added as an explanatory variable to equation (21).) If capital is close to being perfectly mobile, then the U.S. rate should be the only significant explanatory variable in this equation and have a coefficient estimate close to 1.0. If capital is close to being immobile, then the coefficient estimate of the U.S. rate should be close to zero and the other variables should be significant. The in between case would correspond to both the U.S. rate and the other set of variables being significant.

Consider now the flexible exchange rate period. In this period under either polar assumption about capital mobility, one can estimate interest rate reaction functions, and this was done in the empirical work. The only reason one would expect the U.S. rate to be a significant variable in these equations,under either assumption about capital mobility, is if the U.S. rate is one of the variables that affects the monetary authorities' decisions. The mobility assumptions in this case affect not the determination of the interest rate but rather the determination of the exchange rate. Under zero mobility, e is either implicitly determined (matched to equation (6)), with Q exogenous, or determined by an exchange rate reaction function, with Q endogenous (matched to equation (6)). Under perfect mobility, e is determined by the arbitrage condition (23). The approximation that was used in this case was to estimate an equation like the arbitrage condition, but one that allowed there to be more flexibility among the four variables. The more estimated flexibility there is in this relationship, the further removed from the case of perfect mobility will the model be.

To summarize, the in between case of imperfect capital mobility was approximated by 1) estimating separate interest rate reaction functions in the fixed and flexible exchange rate periods, 2) adding the U.S. interest rate to the reaction functions in the fixed rate period, and

3) estimating "flexible" arbitrage conditions in the flexible rate period.

This completes the outline of the theoretical model. Although this outline should help in understanding the main features of the econometric model, much more discussion of the equations is obviously needed. In particular, more discussion is needed of the determination of the forward and spot exchange rates. These and related issues will be discussed in Section III in the process of presenting the estimated equations of the econometric model and in Section V in the process of describing the model's properties.

III. The Econometric Model

The econometric model for all countries except the U.S. is presented in Tables 3-6. The variables for a particular country i are presented in alphabetic order in Table 3; the equations for country i are listed in Table 4; the trade and price linkages among the countries are presented in Table 5; and the coefficient estimates for all the countries are presented in Table 6. The purpose of this section is to explain these tables. To conserve space, it is assumed in the following discussion that the tables have been read carefully. Parts of the tables that are self explanatory are not discussed, and the discussion is not self contained without the tables.

The econometric model for the U.S. is the one discussed in Fair (1976, 1979d). It is much larger than the model for an individual country in Table 4, and it captures many more features of the economy. The two key exogenous foreign sector variables in this model are the import price deflator and the real value of exports, and when the U.S. model is embedded in the overall model, these two variables become endogenous. Since the

TABLE 3. The Variables for Country i in Alphabetic Order

Notes: lc = local currency; all prices are in lc; e and F are in units of lc per $; an * denotes that the variable is in units of lc. † denotes exogenous variable.

Eq. No.	Variable
12	ΔA^*_{it} = change in foreign security and reserve holdings in lc. [Defined in Table 4.]
13	A^*_{it} = a constant plus net stock of foreign security and reserve holdings in lc. [Defined in Table 4 except for base period value.]
	$^{\dagger}D\$_{it}$ = total net transfers in \$. [See Table A-3.]
8b	e_{it} = exchange rate, end of period, lc per \$. [= IFSAE.]
9b,10b	$\bar{e}_{it}$ = exchange rate, average for the period, lc per \$. [= IFSRF.]
7b	F_{it} = three-month forward rate, lc per \$. [= IFSB.]
2	M_{it} = merchandise imports (fob) in 75 lc. [= $(\bar{e}_{it}M\$_{it})/PM_{it}$.]
17	$\bar{M}_{it}$ = merchandise imports (fob) in 75 lc from DOT data. [= $\bar{e}_{i75}M75\$_{it}$.]
20,IV	$^{\dagger}M\$_{it}$ = merchandise imports (fob) in \$. [= IFS71V/IFSRF .]
18	$M75\$_{it}$ = merchandise imports (fob) in 75\$. [= $\sum_j{}' XX75\$_{jit}$.]
4	MP^*_{it} = money supply in lc. [= IFS34.]
	$^{\dagger}MS\$_{it}$ = other goods, services, and income (debit) in \$. Balance of Payments data. [= IFS77ADD.]
21,VI	PM_{it} = import price index, 1975 = 1.0. [= IFS75.]
V	$\widetilde{PM}_{it}$ = import price index implicitly constructed. [= $(\bar{e}_{it}\sum_j{}^{1} XX\$_{jit})/\bar{M}_{it}$.]
	$^{\dagger}POP_{it}$ = population in millions. [= IFS99Z.]
3	PX_{it} = export price index, 1975 = 1.0. [= IFS74.]
14	PXF_{it} = GNP deflator, 1975 = 1.0. [= (IFS99A or IFS99B)/XF_{it} .]
6a,6b	r_{it} = three-month interest rate, percentage points. [= IFS60, IFS60B, or IFS60C.]
5	R_{it} = long-term interest rate, percentage points. [= IFS61 or IFS61A.]
11	$S\$_{it}$ = total net goods, services, and transfer in \$. Balance of Payments on current account. [See Table A-3.]
II	$XX\$_{jit}$ = merchandies exports (fob) from j to i in \$. [DOT tape.]
I	$XX75\$_{jit}$ = merchandise exports (fob) from j to i in 75\$. [= $(\bar{e}_{jt}XX\$_{jit})/(\bar{e}_{j75}PX_{jt})$.]
19,III	$X\$_{it}$ = merchandise exports (fob) in \$. [= IFS70/IFSRF.]
15	XE_{it} = total exports (NIA) in 75 lc. [= (IFS90C or IFS90N)/PXF_{it} .]
16	XF_{it} = real GNP: total production of goods and services (NIA) in 75 lc. [= IFS99AP, IFS99BP, IFS99AR, or IFS99BR.]

TABLE 3 (continued)

Eq. No.	Variable	
	$^{\dagger}XG_{it}$	= government purchases of goods and services (NIA) in 75 lc. [= (IFS91F or IFS91FF)/PXF_{it} .]
1	XP_{it}	= private domestic purchases of the goods and services of country i (NIA) in 75 lc. [= $XF_{it} - XG_{it} - XE_{it}$.]
	$^{\dagger}XS\$_{it}$	= other goods, services, and income (credit) in \$. Balance of Payments data. [= IFS77ACD.]
	$^{\dagger}\alpha_{jit}$	= share of i's total merchandise imports imported from j in 75\$. [= $XX75\$_{jit}/M75\$_{it}$.]
	$^{\dagger}\psi_{1it}$	$= \bar{e}_{it}/((e_{it} + e_{it-1})/2)$.
	$^{\dagger}\psi_{2it}$	$= PXF_{it}/PX_{it}$.
	$^{\dagger}\psi_{3it}$	$= (PX_{it}XE_{it})/(\bar{e}_{it}(X\$_{it} + XS\$_{it}))$.
	$^{\dagger}\psi_{4it}$	$= M_{it}/\bar{M}_{it}$.
	$^{\dagger}\psi_{5it}$	$= PM_{it}/\widetilde{PM}_{it}$.
Also:	$\bar{e}_{i75}$	= average exchange rate in 1975, lc per \$. [= IFSRF for 1975.]
	$XX\$_{i65t}$	$= X\$_{it} - \sum^{0}_{j\neq 65} XX\$_{ijt}$.
	$XX\$_{65it}$	$= M\$_{it} - \sum^{0}_{j\neq 65} XX\$_{jit}$.

Σ^0 denotes summation over all countries. Σ^1 denotes summation only over those countries for which data on $\bar{e}$ and PX exist.

TABLE 4. The List of Equations for Country i

Variables Explained by Stochastic Equations

1. $XP_{it} = f(PX_{it}, PM_{it}, r_{it}$ or $R_{it}, XF_{it}, A^{*}_{it-1}/PX_{it-1}, XP_{it-1})$	[private domestic purchases of country i's goods and services in 75 lc]
2. $M_{it} = f(PX_{it}, PM_{it}, r_{it}$ or $R_{it}, XF_{it}, A^{*}_{it-1}/PX_{it-1}, M_{it-1})$	[merchandise imports in 75 lc]
3. $PX_{it} = f(PM_{it}, PM_{it-1}, r_{it}$ or R_{it}, r_{it-1} or $R_{it-1}, XF'_{it}, PX_{it-1}, PX_{it-2})$	[export price index]
4. $MP^{*}_{it} = f(r_{it}, PXF_{it}XF_{it}, MP^{*}_{it-1})$	[money supply in lc]
5. $R_{it} = f(r_{it}, r_{it-1}, r_{it-2}, R_{it-1}, (\dot{PX}_{it} + \dot{PX}_{it-1} + \dot{PX}_{it-2})/3)$	[long-term interest rate]
6a,6b. $r_{it} = f(r_{1t}, \dot{PX}_{it-1}, \dot{MP}_{it-1}, XF'_{it-1}, r_{it-1})$	[three-month interest rate]
7b. $F_{it} = f(PX_{it}/PX_{1t}, XF_{it}/XF_{1t}, F_{it-1})$	[three-month forward rate]
8b. $e_{it} = f(F_{it}, r_{it}/r_{1t}, e_{it-1})$	[exchange rate, end of period]
or	
9b. $\bar{e}_{it} = f(PX_{it}/PX_{1t}, XF_{it}/X_{1t}, \bar{e}_{it-1})$	[exchange rate, average for the period]

Variables Explained by Definitions

If 8b, 10b. $\bar{e}_{it} = \psi_{1it}(e_{it} + e_{it-1})/2$	[exchange rate, average for the period]
11. $S\$_{it} = X\$_{it} + XS\$_{it} - M\$_{it} - MS\$_{it} + D\$_{it}$	[total net goods, services, and transfers in \$]
12. $\Delta A^{*}_{it} = \bar{e}_{it}S\$_{it}$	[change in foreign security and reserve holdings in lc]
13. $A^{*}_{it} = A^{*}_{it-1} + \Delta A^{*}_{it}$	[net stock of foreign security and reserve holdings in lc]
14. $PXF_{it} = \psi_{2it}PX_{it}$	[GNP deflator]
15. $XE_{it} = \psi_{3it}\bar{e}_{it}(X\$_{it} + XS\$_{it})/PX_{it}$	[total exports (NIA) in 75 lc]
16. $XF_{it} = XP_{it} + XE_{it} + XG_{it}$	[real GNP: total production of goods and services in 75 lc]
17. $\bar{M}_{it} = M_{it}/\psi_{4it}$	[merchandise imports in 75 lc from DOT data]
18. $M75\$_{it} = \bar{M}_{it}/\bar{e}_{i75}$	[merchandise imports in 75\$]

Variables Explained When the Countries Are Linked Together (Table 5)

19. $X\$_{it}$	[merchandise exports in \$]
20. $M\$_{it}$	[merchandise imports in \$]
21. PM_{it}	[import price index]

TABLE 4 (continued)

Exogenous Variables

1. $D\$_{it}$	[total net transfers in \$]
2. $MS\$_{it}$	[other goods, services, and income (debit) in \$]
3. POP_{it}	[population]
4. XG_{it}	[government purchases of goods and services in 75 lc]
5. $XS\$_{it}$	[other goods, services, and income (credit) in \$]
6. ψ_{1it}	[historic ratio of $\bar{e}_{it}$ to $(e_{it}+e_{it-1})/2$]
7. ψ_{2it}	[historic ratio of PXF_{it} to PX_{it}]
8. ψ_{3it}	[historic ratio of $PX_{it}XE_{it}$ to $e_{it}(X\$_{it}+XS\$_{it})$]
9. ψ_{4it}	[historic ratio of M_{it} to $\bar{M}_{it}$]
10. ψ_{5it}	[historic ratio of PM_{it} to $\widetilde{\widehat{PM}}_{it}$]
11. PX_{it} for oil exporting countries	[export price index]
12. $\bar{e}_{i75}$	[exchange rate in 1975]

Notes: 1) A · over a variable denotes percentage change at an annual rate.
2) XF'_{it} is a function of XF_{it} and is interpreted as a demand pressure variable. It is discussed in the text.
3) The arguments in the functions are for illustrative purposes only. The exact explanatory variables and functional forms are presented in Table 6.

TABLE 5. The List of Equations that Pertain to the Trade and Price Linkages Among Countries

Equations

I	$XX75\$_{jit} = \alpha_{jit} M75\$_{it}$	[merchandise exports from j to i in 75$]
II	$XX\$_{jit} = (\bar{e}_{j75} PX_{jt} XX75\$_{jit})/\bar{e}_{jt}$	[merchandise exports from j to i in $]
III	$X\$_{it} = \sum_j^0 XX\$_{ijt}$	[merchandise exports of i in $]
IV	$M\$_{it} = \sum_j^0 XX\$_{jit}$	[merchandise imports of i in $]
V	$\widetilde{PM}_{it} = \dfrac{e_{it} \sum_j^1 XX\$_{jit}}{\overline{M}_{it}}$	[import price index of i implicitly constructed]
VI	$PM_{it} = \psi_{5it} \widetilde{PM}_{it}$	[import price index of i]

Notes: α_{jit} = share of i's total merchandise imports imported from j in 75$.

Case A: α_{jit} is exogenous

Case B: α_{jit} is a function of the price of j relative to an index of all prices. The function is defined as follows. Let

$$\overline{PX}_{jt} = \frac{\bar{e}_{j75}}{\bar{e}_{jt}} PX_{jt} = \text{country } j\text{'s export price index in \$},$$

and let a superscript a denote historic values. The equation determining α_{jit} is:

$$\alpha_{jit} = \alpha^a_{jit} + \beta[\alpha^a_{jit}(\overline{PX}_{jt} - \overline{PX}^a_{jt}) - \frac{1}{N}\sum_k^1 \alpha^a_{kit}(\overline{PX}_{kt} - \overline{PX}^a_{kt})] ,$$

where $\beta < 0$ and N is the number of countries over which the summation is taken. This equation has the property that $\sum_j^1 \alpha_{jit} = 1$, given that $\sum_j^1 \alpha^a_{jit} = 1$.

TABLE 6. Estimated Equations

A * means that the variable is lagged one quarter. t-statistics in absolute value are in parentheses.

Equation 1: $\log\frac{XP_{it}}{POP_{it}}$ is the dependent variable.

Explanatory Variables

Country	$\log PX_{it}$	$\log PM_{it}$	r_{it}	R_{it}	$\log\frac{XF_{it}}{POP_{it}}$	$\frac{A^*_{it-1}}{PX_{it-1}POP_{it-1}}$	$\log\frac{XP_{it-1}}{POP_{it-1}}$	$\log\frac{XP_{it-2}}{POP_{it-2}}$	t	R^2	SE	DW	Sample Period
Canada				-.0097*	.32	.000011	.61			.989	.0151	1.99	581-784
				(3.21)	(4.95)	(1.08)	(7.42)						
Japan			-.0040*		.44		.62		-.0015	.999	.0145	1.92	581-791
			(5.40)		(3.47)		(5.85)		(2.82)				
Austria	-.18*	.12*	-.0039*		.46		.20			.975	.0259	1.77	651-784
	(0.89)	(0.64)	(0.63)		(5.25)		(1.49)						
Belgium	-.30*	.22*	-.00093*		.16		.64			.889	.0327	2.03	581-774
	(1.32)	(1.13)	(0.32)		(2.64)		(6.22)						
Denmark				-.025	.87		.32			.986	.0211	1.44	581-784
				(9.62)	(12.11)		(5.81)						
France	-.065*	.016*		-.0053	.47	.0039	.55			.999	.0077	1.94	581-784
	(1.21)	(0.40)		(2.74)	(4.61)	(1.14)	(5.76)						
Germany				-.0087	.53		.75		-.0031	.968	.0156	1.93	631-784
				(4.67)	(2.10)		(6.75)		(1.96)				
Italy				-.0045*	.34	.00013	.44			.987	.0145	2.42	611-783
				(2.29)	(5.33)	(3.95)	(5.56)						
Netherlands			-.0026*		.05		.89			.882	.0444	2.16	611-784
			(1.21)		(1.21)		(14.97)						
Norway					.098		.83			.916	.0333	2.01	621-784
					(2.28)		(11.44)						
Sweden	-.16*	.096*	-.0016		.17		.74			.922	.0278	2.15	581-784
	(1.36)	(0.75)	(0.32)		(2.03)		(7.65)						
Switzerland				-.0042*	.073		.93			.982	.0176	1.71	581-784
				(1.52)	(1.37)		(14.18)						
U.K.				-.011*	.39	.00029	.43			.883	.0263	1.91	631-784
				(3.85)	(4.48)	(2.12)	(4.64)						
Finland					.26	.000018	.73			.982	.0263	2.32	581-784
					(4.43)	(4.01)	(11.33)						
Greece			-.010*		.70		.21			.995	.0226	1.00	581-784
			(8.37)		(14.26)		(3.87)						
Ireland				-.014*	.37		.70			.905	.0506	2.11	581-764
				(4.35)	(4.72)		(11.01)						
Portugal	-.046*	.17*	-.0033*		.27	.0027	.57			.987	.0360	1.69	581-784
	(0.36)	(1.74)	(0.87)		(2.29)	(2.29)	(4.48)						
Spain	-.036*	.021			.77	.0011	.18			.998	.0096	1.63	621-774
	(1.35)	(1.42)			(14.14)	(2.63)	(3.17)						
Yugoslavia					.33		.61			.975	.0349	1.84	611-764
					(4.41)		(6.78)						
Australia				-.0088*	.80		.15			.990	.0172	1.58	603-784
				(4.55)	(10.64)		(1.95)						
New Zealand			-.0073*		.18		1.44	-.64		.992	.0118	1.97	582-771
			(2.87)		(4.66)		(17.12)	(8.04)					
South Africa				-.013*	.36		.78			.946	.0249	2.33	621-784
				(3.06)	(2.62)		(10.11)						
Iran			-.0054*		.046		1.62	-.70		.980	.0289	1.90	614-774
			(1.38)		(2.28)		(17.12)	(7.20)					
Libya					.16		1.31	-.55		.805	.2266	2.08	652-774
					(2.02)		(11.22)	(4.96)					
Nigeria					.11		.89	-.24		.656	.0743	1.61	712-761
					(0.92)		(3.76)	(0.94)					
Saudi Arabia							1.62	-.68		.960	.1260	2.01	673-772
							(12.86)	(5.42)					
Venezuela					.10		1.56	-.70		.934	.0364	1.93	621-774
					(1.80)		(16.45)	(7.46)					
Brazil					.59	.013	.52	-.26	.0028	.999	.0057	1.52	641-764
					(7.24)	(2.63)	(3.76)	(3.35)	(6.00)				
Chile					.55		.42	.11		.847	.0424	1.16	641-774
					(4.20)		(3.48)	(1.07)					
Colombia					.32		1.25	-.63		.990	.0054	2.07	711-774
					(3.80)		(8.56)	(5.03)					
Mexico					.47	.052	.47			.791	.0197	1.32	711-774
					(4.05)	(2.60)	(3.73)						
Peru			-.0042*		.37		1.38	-.67		.985	.0128	2.22	641-782
			(2.85)		(4.67)		(13.43)	(7.15)					
Egypt					.076		1.60	-.78		.933	.0154	2.07	661-764
					(2.02)		(14.16)	(6.53)					
Syria	-.053*	.099*			.086		1.38	-.64		.960	.0320	2.07	641-774
	(1.56)	(2.31)			(0.96)		(11.73)	(6.01)					
China	-.30	.16			.018		.54			.540	.0696	1.90	641-784
	(1.11)	(0.76)			(0.24)		(4.72)						
Korea					.36	.00086	.06	.36		.988	.0597	1.48	641-774
					(4.92)	(0.97)	(0.65)	(4.92)					
Malaysia						.00034	.30			.743	.0399	1.80	721-774
						(3.43)	(1.85)						
Phillippines			-.0046*		.50		.33			.944	.0295	1.62	581-784
			(2.70)		(9.47)		(4.72)						
Thailand					.39		1.16	-.60		.997	.0105	2.00	621-784
					(6.82)		(12.48)	(8.33)					

TABLE 6 (continued)

Equation 2: $\log \frac{M_{it}}{POP_{it}}$ is the dependent variable.

Country	$\log PX_{it}$	$\log PM_{it}$	r_{it}	R_{it}	$\log \frac{XF_{it}}{POP_{it}}$	$\frac{A^*_{it-1}}{PX_{it-1}POP_{it-1}}$	$\log \frac{M_{it-1}}{POP_{it-1}}$	$\log \frac{M_{it-2}}{POP_{it-2}}$	t	R^2	SE	DW	Sample Period
					Explanatory Variables								
Canada	.36	-.45		-.0046*	1.05	.000054	.49			.992	.0368	1.91	581-784
	(1.77)	(2.17)		(0.55)	(5.85)	(1.54)	(4.90)						
Japan	.099*	-.099*	-.0044*		.30	.00014	.77			.995	.0468	2.01	581-791
	(1.67)	(1.67)	(1.32)		(2.21)	(0.60)	(8.43)						
Austria			-.016*		1.45		.27			.989	.0385	1.85	651-784
			(1.97)		(5.77)		(2.18)						
Belgium				-.026*	.67		.74			.995	.0400	2.39	581-774
				(2.96)	(3.64)		(9.17)						
Denmark	.35*	-.48*		-.0063*	.37	.024	.40		.011	.987	.0464	2.13	581-784
	(1.64)	(2.50)		(0.76)	(1.41)	(2.58)	(4.13)		(3.80)				
France			-.0056*		.53		.77			.993	.0499	1.86	581-784
			(1.68)		(2.72)		(8.46)						
Germany			-.0053*		1.14		.50			.993	.0288	1.92	631-784
			(3.34)		(4.16)		(4.11)						
Italy	.46	-.27		-.0135*	.92	.00031	.47			.974	.0637	2.31	611-783
	(0.99)	(0.72)		(0.85)	(1.97)	(0.96)	(4.43)						
Netherlands	.11*	-.18*	-.0017*		1.32		.36			.992	.0335	2.07	611-784
	(0.43)	(0.84)	(1.01)		(5.67)		(3.16)						
Norway				-.028*	1.31	.016	.47			.970	.0601	2.35	621-784
				(1.66)	(5.09)	(4.23)	(4.74)						
Sweden	.31*	-.29*			1.17	.025	.38			.984	.0440	2.46	581-784
	(1.53)	(1.45)			(6.74)	(3.05)	(4.15)						
Switzerland			-.035*		1.89	.0093	.26			.993	.0318	2.08	581-784
			(5.45)		(6.69)	(2.04)	(2.29)						
U.K.					.45		.75			.964	.0493	2.23	581-784
					(3.33)		(10.38)						
Finland	.63	-.63			1.39	.000056	.24			.971	.0910	2.33	581-784
	(1.51)	(1.51)			(7.47)	(4.50)	(2.33)						
Greece					1.05		.25			.962	.1053	2.38	581-784
					(6.42)		(2.18)						
Ireland	.29	-.28			.71		.59			.980	.0590	2.48	581-764
	(1.76)	(1.68)			(3.74)		(6.21)						
Portugal					1.18	.00078	.15			.910	.1622	2.08	581-784
					(5.76)	(0.23)	(1.17)						
Spain			-.028		.63		.67			.978	.0633	2.32	621-774
			(1.93)		(3.36)		(7.70)						
Yugoslavia					.57	.050	.59			.948	.0909	2.04	611-764
					(3.35)	(2.39)	(5.39)						
Australia	.18*	-.12*		-.023*	.47		.69			.872	.0650	1.75	603-784
	(2.05)	(1.38)		(1.78)	(3.72)		(8.19)						
New Zealand					.99	.00029	.42			.848	.0832	2.03	582-771
					(5.86)	(4.01)	(4.42)						
South Africa	.44	-.44	-.020*		.66		.71			.904	.0631	1.88	631-784
	(2.27)	(2.27)	(2.20)		(3.91)		(11.20)						
Iran					.59	.0066	.58			.971	.0939	1.55	711-774
					(2.02)	(2.02)	(3.71)						
Libya					.21		.78			.952	.0878	2.24	711-774
					(1.62)		(8.10)						
Nigeria						.0044	.57			.949	.1003	1.48	712-761
						(4.23)	(4.71)						
Saudi Arabia					.60	.049	.42			.993	.0646	2.20	711-772
					(2.49)	(3.93)	(2.64)						
Venezuela					1.78	.000021	.48			.909	.0879	2.13	711-774
					(2.14)	(0.80)	(2.72)						
Argentina						.110	.53			.511	.1461	1.70	711-754
						(1.87)	(2.64)						
Brazil					.93	.18	.93	-.21*		.935	.0903	1.45	711-764
					(1.60)	(1.21)	(3.30)	(0.82)					
Chile					1.14	.00039	.68			.753	.2550	2.44	641-774
					(1.84)	(1.09)	(6.94)						
Colombia			-.030*			.000055	.70			.526	.0902	1.87	711-774
			(1.67)			(1.98)	(4.41)						
Mexico					1.35	.15	.72			.938	.0463	1.99	711-774
					(4.30)	(3.20)	(8.79)						
Peru			-.025*		1.50	.032	.68			.865	.1168	2.29	711-782
			(1.37)		(2.01)	(2.62)	(4.43)						
Egypt					.27	.0012	1.01			.944	.1278	1.63	711-764
					(0.22)	(0.23)	(9.15)						
Israel					.83	.000014	.24			.540	.1210	2.37	691-783
					(2.62)	(1.10)	(1.30)						
Syria					.90	.000049	.44			.792	.1513	2.31	641-774
					(2.99)	(0.44)	(3.44)						
China					.86		.60			.972	.1118	2.75	641-784
					(3.89)		(6.26)						
Korea	.52	-.52			.77	.00116	.68			.979	.1119	2.21	641-774
	(2.78)	(2.78)			(4.22)	(0.73)	(8.10)						
Malaysia	.46*	-.56*			.41		.23			.923	.0342	1.82	721-774
	(3.20)	(5.31)			(1.71)		(1.34)						
Phillippines			-.013		.29	.000083	.52			.503	.1121	2.26	581-784
			(1.68)		(2.47)	(1.10)	(5.42)						
Thailand	.08	-.23	-.017		.84	.044	.52			.946	.0585	2.02	621-784
	(0.50)	(1.74)	(1.87)		(3.50)	(0.83)	(4.85)						

TABLE 6 (continued)

Equation 3: $\log PX_{it}$ is the dependent variable.

b,c, and d refer to the value of k used in equation (3.1): b = 4, c = 5, d = 6.

Explanatory Variables

Country	$\log PM_{it}$	$\log PM_{it-1}$	r_{it}	r_{it-1}	R_{it}	R_{it-1}	$\log \frac{XF'_{it}}{POP_{it}}$	$\log PX_{it-1}$	$\log PX_{it-2}$	t	R^2	SE	DW	Sample Period
Canada	.58	-.54	.0043	-.0043			$-.033^{b*}$	1.06	-.11	.00020	.999	.0104	1.96	581-784
	(6.70)	(5.75)	(1.42)	(1.56)			(4.64)	(10.64)	(1.11)	(1.77)				
Japan	.50	-.43						.92	-.04	-.000038	.989	.0194	1.78	584-791
	(9.46)	(7.32)						(9.52)	(0.43)	(0.26)				
Austria	.43	.42		.0073			$-.092^{d}$	.20	-.10	.00044	.991	.0174	1.79	651-784
	(3.23)	(2.46)		(1.58)			(3.74)	(1.36)	(0.83)	(0.99)				
Belgium	.45	-.04	.0046	-.0017			$-.029^{b}$	.45	.06	.00028	.996	.0128	1.95	581-774
	(5.65)	(0.35)	(1.36)	(0.68)			(3.41)	(3.39)	(0.58)	(2.32)				
Denmark	.44	-.17						.67	.00	.00070	.996	.0192	1.97	581-784
	(4.51)	(1.54)						(5.75)	(0.01)	(3.03)				
France	.42	-.16	.0043	-.0040			$-.0056^{b}$	.72	-.02	.00080	.999	.0128	1.99	581-784
	(6.81)	(2.16)	(1.02)	(1.19)			(0.49)	(5.14)	(0.17)	(2.11)				
Germany	.27	-.13					$-.018^{b*}$	1.13	-.27	.00034	.998	.0088	2.21	631-784
	(5.47)	(2.28)					(2.66)	(9.66)	(2.77)	(1.68)				
Italy	.47	-.29 .		.0033			$-.015^{d*}$	.72	.06	-.000014	.999	.0148	2.08	611-783
	(11.10)	(4.67)		(1.79)			(0.64)	(6.42)	(0.72)	(0.06)				
Netherlands	.48	-.02			.002	-.016		.32	.15	-.00036	.997	.0132	2.12	611-784
	(5.22)	(0.13)			(2.18)	(2.01)		(2.17)	(1.47)	(1.16)				
Norway	.75	-.49			.056	-.049	$-.020^{b}$	.68	.02	.00032	.994	.0236	2.20	621-784
	(4.95)	(2.41)			(1.53)	(1.70)	(0.69)	(5.00)	(0.11)	(0.70)				
Sweden	.36	-.15					$-.0037^{d}$	.95	-.17	.00027	.999	.0121	2.20	581-784
	(5.98)	(2.05)					(0.19)	(8.14)	(1.70)	(1.37)				
Switzerland	.31	-.05					$-.031^{d*}$	.29	.34	.0014	.996	.0131	1.94	581-784
	(4.33)	(0.57)					(2.46)	(2.74)	(3.62)	(2.85)				
U.K.	.31	-.24					$-.0035^{d*}$	1.15	-.22	.000050	.999	.0088	1.95	581-784
	(10.01)	(6.29)					(0.50)	(12.33)	(2.76)	(0.43)				
Finland	.73	-.30					$-.028^{d}$	.55	.03	.000056	.998	.0252	2.05	581-784
	(8.71)	(2.37)					(1.14)	(5.14)	(0.43)	(0.16)				
Greece	.26	.02					$-.055^{b*}$	.71	-.04	.00039	.985	.0448	1.93	581-784
	(2.34)	(0.15)					(2.07)	(5.96)	(0.30)	(0.94)				
Ireland	.12	-.15					$-.010^{d}$	1.07	-.01	.000157	.998	.0174	1.92	581-764
	(1.09)	(1.56)					(0.53)	(9.00)	(0.08)	(0.67)				
Portugal	.30	.18					$-.109^{b}$	.41	.10	.0012	.992	.0398	1.87	581-784
	(1.80)	(1.02)					(3.71)	(3.88)	(0.94)	(1.66)				
Spain	.47	-.28						.38	.34	.00049	.982	.0419	1.97	621-774
	(4.04)	(2.20)						(2.99)	(2.65)	(0.57)				
Australia	.21	-.18						1.23	-.30	.00052	.989	.0338	2.00	603-784
	(1.40)	(1.30)						(10.39)	(2.37)	(1.41)				
New Zealand	.19	-.13			.039	-.035		1.41	-.50	.00017	.990	.0328	1.88	582-771
	(1.46)	(0.95)			(0.95)	(0.87)		(12.28)	(4.32)	(0.45)				
South Africa	.37	-.09					$-.064^{d*}$	.82	-.11	-.00050	.991	.0349	2.04	621-784
	(2.89)	(0.66)					(1.50)	(6.30)	(0.93)	(0.80				
Brazil	.20	.10						1.05	-.68	.028	.992	.0640	2.00	711-764
	(0.78)	(0.43)						(4.69)	(2.77)	(2.10)				
Israel	.81	-.69						.92	-.02	-.00089	.997	.0454	1.94	691-783
	(6.64)	(4.54)						(6.28)	(0.13)	(0.33)				
Syria	.82	-.53						1.23	-.50	.00091	.987	.0689	1.85	641-774
	(3.50)	(2.03)						(11.64)	(4.84)	(0.65)				
China	.29	.01	.022	-.019			$-.065^{d*}$	.51	.08	.00065	.979	.0454	1.55	641-784
	(1.66)	(0.05)	(0.91)	(0.94)			(1.39)	(3.37)	(0.49)	(0.43)				
Korea	.74	-.50	.0059	-.0023			$-.041^{b*}$	.71	-.13	.0053	.995	.0384	2.03	641-774
	(8.33)	(4.07)	(1.03)	(0.48)			(0.50)	(5.90)	(1.52)	(3.12)				
Malaysia	1.01	-.64						1.17	-.52		.951	.0775	2.02	721-774
	(1.61)	(1.21)						(4.76)	(2.06)					
Phillippines	.79	-.56						1.08	-.39	.00015	.989	.0632	2.16	631-784
	(5.19)	(3.93)						(9.55)	(3.37)	(0.09)				
Thailand	.70	-.61						.82	.02	.00070	.980	.0521	2.20	621-784
	(3.24)	(3.05)						(5.17)	(0.15)	(1.14)				

TABLE 6 (continued)

Equation 4: MP^*_{it}/POP_{it} is the dependent variable.

Country	r_{it}	$\frac{PX_{it}XF_{it}}{POP_{it}}$	$\frac{MP^*_{it-1}}{POP_{it-1}}$	t	R^2	SE	DW	Sample Period
	Explanatory Variables							
Canada	-6.3	.032	.95	.27	.994	18.0	2.51	581-784
	(3.42)	(2.50)	(20.01)	(0.97)				
Japan	-.44*	.37	.72	.03	.997	10.4	2.59	581-791
	(0.80)	(2.93)	(7.71)	(0.21)				
Austria	-.037	.32	.49	.012	.996	.312	1.83	651-784
	(0.52)	(3.58)	(3.91)	(0.88)				
Belgium	-.36	.24*	.71	.046	.997	.931	2.63	581-774
	(4.34)	(4.98)	(11.24)	(2.94)				
Denmark	-.13	.30	.57	.014	.995	.228	2.08	581-784
	(3.40)	(6.69)	(8.37)	(3.03)				
France	-.027*	.29	.64	.0089	.996	.159	2.36	581-784
	(2.74)	(5.43)	(8.58)	(2.88)				
Germany	-.013	.19	.76	-.0013	.997	.0411	2.41	631-784
	(3.42)	(2.59)	(7.91)	(0.76)				
Italy	-4.8*	.28	.95	.025	.998	21.7	2.66	611-783
	(1.94)	(2.08)	(15.44)	(0.06)				
Netherlands	-.029	.45*	.38	.0050	.997	.0638	2.35	611-784
	(6.00)	(8.32)	(5.74)	(3.07)				
Norway	-.20	.49*	.33	.018	.988	.281	2.30	621-784
	(1.35)	(5.36)	(2.73)	(3.08)				
Sweden	-.013*	.071*	.89	-.0025	.993	.0813	2.15	581-784
	(1.04)	(2.83)	(17.43)	(1.86)				
Switzerland	-.053*	.036	.93	.0068	.995	.189	2.07	581-784
	(2.35)	(0.44)	(15.51)	(1.40)				
U.K.	-1.3	.15	.78	-.0082	.998	4.35	2.50	581-784
	(4.29)	(4.59)	(13.04)	(0.16)				
Finland		.13*	.68	-.93	.991	62.2	2.57	581-784
		(3.88)	(8.13)	(1.17)				
Greece	-.020	.27	.63	.0030	.994	.461	2.29	581-784
	(0.50)	(3.34)	(5.06)	(0.45)				
Ireland	-1.2*	.053	.99	.022	.995	4.13	2.53	581-764
	(3.08)	(2.67)	(18.32)	(0.27)				
Portugal		.087*	.96	.0066	.994	.597	2.21	581-784
		(1.20)	(17.25)	(0.91)				
Spain	-.12	.14*	.93	.0048	.995	1.42	2.94	631-774
	(0.27)	(1.10)	(8.36)	(0.15)				
Australia	-6.5*	.14	.71	.16	.997	9.51	1.29	603-784
	(4.62)	(5.34)	(11.60)	(1.13)				
New Zealand	-12.0*	.16	.76	-.62	.986	13.0	2.44	582-771
	(4.10)	(4.05)	(12.33)	(2.58)				
South Africa	-1.4	.057	.82	.23	.994	3.32	2.05	621-784
	(2.92)	(2.13)	(11.76)	(2.90)				
Iran	-.073*	.11	.83	.0085	.993	.526	1.98	614-774
	(1.08)	(3.32)	(12.73)	(1.00)				
China	-.32	1.00	-.00	-.034	.961	.699	1.60	641-784
	(3.75)	(12.56)	(0.13)	(2.03)				
Korea	-.0050	.062	.92	.0075	.997	.928	2.24	641-774
	(0.21)	(2.59)	(12.86)	(0.37)				
Phillippines		.052*	.88	.024	.995	5.95	1.99	581-784
		(2.69)	(14.43)	(0.39)				
Thailand	-.0039*	.25	.35	.00012	.989	.0244	1.70	621-784
	(1.34)	(4.60)	(2.41)	(0.27)				

TABLE 6 (continued)

Equation 5: R_{it} is the dependent variable.

$3\dot{PX}_{it}$ = average percentage change in PX (at an annual rate) for quarters t , t-1, and t-2 .

Country	r_{it}	r_{it-1}	r_{it-2}	R_{it-1}	R_{it-2}	$3\dot{PX}_{it}$	t	R^2	SE	DW	Sample Period
	Explanatory Variables										
Canada	.16	-.11	.01	.80		.0077	.0079	.983	.230	1.76	581-784
	(1.65)	(0.87)	(0.19)	(11.91)		(1.93)	(1.97)				
Belgium	.09	.03	-.04	.73		.0028	.0087	.983	.176	1.38	581-774
	(1.76)	(0.71)	(1.47)	(11.50)		(0.46)	(3.69)				
Denmark	-.06	.37	-.22	.66		.044	.034	.973	.554	1.95	581-784
	(0.20)	(1.07)	(1.36)	(7.86)		(1.88)	(3.19)				
France	.08	-.00	.02	.68		.016	.013	.987	.221	2.06	581-774
	(1.12)	(0.06)	(0.56)	(11.32)		(1.62)	(3.67)				
Germany	.24	-.15	.02	.83		.0094	-.0034	.944	.330	1.68	631-784
	(4.01)	(2.11)	(0.34)	(12.79)		(0.58)	(1.41)				
Italy	.08	.07	-.09	1.26	-.35	.0100	.00079	.990	.303	1.62	611-783
	(0.98)	(0.79)	(1.72)	(11.66)	(3.06)	(1.23)	(0.14)				
Netherlands	.07	-.13	.04	.78		.015	.0075	.974	.279	1.78	611-784
	(4.63)	(3.59)	(1.74)	(12.42)		(2.43)	(2.00)				
Norway	-.16	.67	-.25	.66		.0049	.0054	.979	.176	1.60	621-784
	(0.97)	(3.87)	(1.93)	(6.45)		(1.60)	(1.72)				
Sweden	.34	-.24	-.04	.91		.0012*	.0042	.991	.167	1.64	581-784
	(3.87)	(2.59)	(0.81)	(15.60)		(0.33)	(1.21)				
Switzerland	.44	-.30	.10	.72		.021	.0044	.977	.190	1.34	581-784
	(3.35)	(1.74)	(1.02)	(9.72)		(1.89)	(2.53)				
U.K.	.44	-.38	.08	.73		.055	.0073	.987	.399	2.01	581-784
	(5.79)	(3.89)	(1.28)	(12.95)		(3.17)	(1.60)				
Portugal	.14	.14	-.09	.82		.0039	.0013	.990	.324	1.37	581-784
	(1.90)	(1.88)	(1.38)	(12.74)		(0.63)	(0.38)				
Australia	.39	-.20	-.11	.91		.0040*	.0011	.992	.188	1.52	603-784
	(4.34)	(1.94)	(1.83)	(13.46)		(1.89)	(0.47)				
New Zealand	.37	-.06	-.27	.89		.0066	.0020	.970	.158	1.46	582-771
	(3.45)	(0.53)	(3.84)	(14.17)		(3.97)	(1.27)				
South Africa	.46	-.41	.03	.88		.0077*	.0035	.991	.203	1.32	621-784
	(3.05)	(1.82)	(0.29)	(14.83)		(2.20)	(0.63)				

Equation 6a: r_{it} is the dependent variable. A • denotes percentage change at an annual rate. See the notes for equation 3 for the explanation of b, c, and d.

Country	U.S. Rate: r_{1t}	PX_{it-1}	$\frac{MP_{it-1}}{POP_{it-1}}$	XF'_{it}	r_{it-1}	t	R^2	SE	DW	Sample Period
			Explanatory Variables							
Canada	.76	.066			.33	-.015	.897	.519	1.16	581-701
	(4.66)	(1.93)			(2.79)	(1.34)				
Japan			.0066	-42.4^{b*}	.40	-.16	.777	.867	2.05	581-712
			(0.59)	(4.32)	(3.40)	(4.45)				
Austria	.13			-11.4^{d*}	.71	-.0060	.873	.196	2.21	651-711
	(2.50)			(2.17)	(4.82)	(0.78)				
Belgium	.39	.022		-6.6^{b}	.72	-.016	.894	.516	2.09	581-712
	(4.18)	(1.99)		(1.55)	(8.33)	(1.55)				
Denmark				-5.1^{b}	.78	.0071	.882	.442	1.51	581-724
				(2.22)	(9.13)	(1.15)				
France	.20	.022			.81	-.0025	.897	.620	1.42	581-713
	(1.74)	(1.84)			(12.21)	(0.25)				
Germany	.28	.021		-20.4^{b*}	.71		.993	.605	1.43	631-711
	(2.87)	(0.71)		(3.16)	(9.41)					
Italy	.08		.0042		.88		.898	.235	2.12	611-712
	(3.09)		(0.64)		(12.27)					
Netherlands	.52	.0034	.0095		.68	-.010	.956	.493	1.63	611-711
	(4.04)	(0.27)	(0.75)		(6.27)	(0.52)				
Norway	.04	.0091	.0021		.82	.00049	.896	.150	1.77	621-712
	(1.16)	(1.85)	(1.25)		(8.36)	(0.10)				
Sweden	.20	.0082		$-.60^{d}$	.72	-.0056	.864	.341	2.30	581-724
	(3.54)	(0.77)		(0.27)	(9.72)	(1.36)				
Switzerland	.07	.0024	.0018	-1.7^{d*}	.84	-.00060	.924	.196	2.04	581-711
	(1.76)	(0.61)	(0.44)	(0.86)	(10.64)	(0.10)				
U.K.	.20	.0042		-17.3^{d*}	.72	-.0030	.892	.494	1.64	581-712
	(2.32)	(0.30)		(3.21)	(9.83)	(0.32)				
Finland		.0012		-1.6^{d}	.48	.0022	.191	.289	1.70	581-712
		(0.89)		(1.01)	(2.56)	(0.84)				
Greece			.0014	-2.5^{b*}	.95	.0071	.934	.603	2.00	581-784
			(0.35)	(1.68)	(30.15)	(2.48)				
Ireland	.15		.0027		.63	.015	.817	.630	1.92	581-712
	(1.27)		(0.51)		(5.86)	(1.36)				
Portugal	.011	.00037	.0019	-1.2^{b}	.93	.00091	.941	.130	2.26	581-712
	(0.47)	(0.20)	(0.84)	(1.03)	(11.93)	(0.28)				
Spain	.12		.000021		.92	-.0055	.938	.181	2.47	621-712
	(2.95)		(0.53)		(11.44)	(0.79)				
Australia	.09			-6.8^{b*}	.89	-.011	.933	.211	1.80	603-712
	(1.88)			(4.22)	(14.69)	(1.74)				
New Zealand				-1.4^{b}	.76	.0018	.651	.185	1.75	582-712
				(0.91)	(8.05)	(0.97)				
South Africa				-4.2^{d*}	.93	.0072	.953	.391	0.97	621-784
				(2.01)	(16.54)	(1.53)				
Iran	.12			-2.9^{b}	.81	.0065	.939	.438	2.02	614-774
	(2.42)			(1.60)	(13.19)	(1.26)				
China	.15	.0070	.0068	-2.7^{d}	.90	-.017	.883	.496	1.51	641-784
	(2.58)	(2.28)	(2.06)	(1.42)	(13.64)	(3.06)				
Korea	.052		.00082		.87	-.044	.857	2.576	1.88	641-774
	(0.18)		(0.05)		(14.49)	(1.65)				
Thailand	.23	.0017	.0023		.68	.0027	.788	.683	1.33	621-784
	(2.77)	(0.55)	(0.39)		(7.97)	(0.42)				

TABLE 6 (continued)

Equation 6b: r_{it} is the dependent variable.

See the notes for equation 6a.

Country	U.S. Rate: r_{1t}	PX_{it-1}	$\frac{MP^*_{it-1}}{POP_{it-1}}$	XF'_{it}	r_{it-1}	t	R^2	SE	DW	Sample Period
	Explanatory Variables									
Canada	.22	.010	.037	-4.7^{b}	.83	.04	.956	.536	1.55	711-784
	(1.74)	(0.74)	(2.59)	(0.66)	(8.57)	(1.67)				
Japan		.0078		-41.4^{b*}	1.03	.30	.980	.513	1.74	722-791
		(1.26)		(6.03)	(22.65)	(5.27)				
Austria				-13.7^{d*}	.79	.018	.738	.466	1.92	723-784
				(2.40)	(6.40)	(0.94)				
Belgium		.055	.056	-43.9^{b}	.50	.23	.871	1.166	1.89	722-774
		(1.50)	(1.24)	(2.05)	(3.43)	(2.74)				
Denmark				-8.6^{b}	.81	-.0014	.684	.579	2.41	732-784
				(2.00)	(5.52)	(0.06)				
France		.060		-45.8^{b}	.62	.14	.920	.804	1.56	722-784
		(2.80)		(2.35)	(6.84)	(2.06)				
Germany	.22			-39.9^{b*}	.58	-.019	.853	1.281	1.88	722-784
	(0.71)			(2.27)	(3.62)	(0.32)				
Italy		.021	.059		.67	.10	.875	1.450	1.99	722-783
		(1.19)	(1.66)		(3.47)	(1.14)				
Netherlands	.54			-85.5^{d}	.37	.32	.722	2.230	1.73	722-784
	(1.36)			(2.46)	(2.43)	(2.32)				
Norway	.06	.0026	.00081	-2.8^{b}	.58	.040	.905	.320	1.73	722-784
	(1.04)	(0.64)	(0.38)	(0.60)	(3.00)	(1.86)				
Sweden		.015		-13.6^{d}	.88	.070	.805	.567	1.42	732-784
		(0.95)		(1.34)	(5.00)	(1.60)				
Switzerland	.11	.017	.0017	-4.6^{d*}	.70	-.034	.976	.304	2.50	722-784
	(1.69)	(1.64)	(0.25)	(1.23)	(9.03)	(1.46)				
U.K.	.22		.020	-10.1^{d*}	.78	-.014	.743	1.430	1.31	722-784
	(0.76)		(0.67)	(0.54)	(5.70)	(0.30)				
Finland	.01			-5.8^{d}	.88	.014	.836	.376	2.04	722-784
	(0.15)			(0.93)	(6.88)	(0.37)				
Ireland	.41	.0046	.0059	-1.2^{d}	.45	.11	.787	1.459	1.51	722-764
	(0.74)	(0.13)	(0.15)	(0.13)	(0.97)	(0.71)				
Portugal		.012	.012	-7.3^{b}	.87	.18	.938	1.339	2.28	722-784
		(0.98)	(0.57)	(1.20)	(6.78)	(1.95)				
Spain	.10	.00075			.67	.046	.954	.246	2.37	722-774
	(2.38)	(0.41)			(4.53)	(2.25)				
Australia	.13			-30.8^{b*}	.77	.091	.911	.603	2.67	722-784
	(1.38)			(2.98)	(7.44)	(2.56)				
New Zealand		.0041	.0048		.70	.080	.913	.450	1.97	722-771
		(0.72)	(0.81)		(2.94)	(1.97)				

TABLE 6 (continued)

Equation 7b: $\log F_{it}$ is the dependent variable.

	Explanatory Variable						
Country	$\log\frac{PX_{it}}{PX_{1t}}$	$\log\frac{(XF_{it}/POP_{it})}{(XF_{1t}/POP_{1t})}$	$\log F_{it-1}$	R^2	SE	DW	Sample Period
Canada	.21 (1.18)		.90 (constrained)		.0209	1.39	711-784
Japan	.26 (1.36)		.82 (5.71)	.892	.0561	1.41	722-791
Austria	.31 (0.92)	.37* (0.58)	.76 (3.26)	.862	.0584	1.82	722-784
Belgium	.29 (0.94)		.59 (2.32)	.593	.0554	1.37	722-774
Denmark	.18 (0.52)	.58 (1.64)	.56 (2.17)	.479	.0478	1.76	732-784
France		.08* (0.21)	.78 (4.90)	.544	.0522	1.25	722-784
Germany	.29 (0.89)		.75 (3.14)	.837	.0633	1.55	722-784
Netherlands	.50 (0.87)		.69 (2.18)	.826	.0562	1.65	722-784
Norway	.45 (1.39)		.70 (5.60)	.703	.0474	1.57	722-784
Sweden	.22 (1.00)		.45 (2.00)	.400	.0467	1.34	732-784
Switzerland	.27 (0.89)	.41* (0.94)	.77 (3.80)	.923	.0757	1.75	722-784
U.K.		.20 (0.38)	.92 (12.92)	.904	.0493	1.49	722-784
Finland	.11 (1.31)		.66 (4.49)	.598	.0375	1.86	722-784

TABLE 6 (continued)

Equation 8b: $\log e_{it}$ is the dependent variable.

Country	Explanatory Variables: $\log F_{it}$	$\frac{1}{4}\log\frac{(1+r_{1t}/100)}{(1+r_{it}/100)}$	$\log e_{it-1}$	const.	R^2	SE	DW	Sample Period
Canada	1.02	.93			.999	.0020	1.56	711-784
	(157.44)	(10.88)						
Japan	.80	.89	.20		.989	.0160	1.38	722-791
	(14.17)	(1.96)	(3.42)					
Austria	1.03	1.15		.12	.997	.0085	1.56	722-784
	(71.52)	(1.79)		(2.01)				
Belgium	1.00	1.48			.991	.0075	2.13	722-774
	(2080.85)	(4.97)						
Denmark	1.00	1.86			.950	.0125	2.09	732-784
	(1040.16)	(2.43)						
France	.97	.87	.027		.998	.0032	2.20	722-784
	(82.31)	(6.46)	(2.24)					
Germany	.96	.56	.037		.999	.0042	1.26	722-784
	(74.57)	(3.79)	(2.85)					
Netherlands	1.00	.82			.998	.0049	2.01	722-784
	(6259.72)	(6.05)						
Norway	1.00	1.95			.947	.0185	2.48	722-784
	(1340.98)	(1.83)						
Sweden	1.00	1.08			.975	.0084	1.58	732-784
	(3074.96)	(2.81)						
Switzerland	1.00	1.13			.999	.0060	1.23	722-784
	(2525.15)	(3.90)						
U.K.	.95	1.20	.054		.999	.0054	1.74	722-784
	(42.11)	(6.01)	(2.38)					
Finland	.99	2.07			.950	.0122	1.63	722-784
	(304.09)	(3.21)						

TABLE 6 (continued)

Equation 9b: $\log \bar{e}_{it}$ is the dependent variable.

Country	$\log \frac{PX_{it}}{PX_{1t}}$	$\log \frac{(XF_{it}/POP_{it})}{(XF_{1t}/POP_{1t})}$	$\log \bar{e}_{it-1}$	t	R^2	SE	DW	Sample Period
	Explanatory Variables							
Italy	.59	.36	.40		.957	.0407	1.12	722-783
	(1.93)	(1.19)	(1.36)					
Ireland	.28	.088*	.66	.0053	.942	.0399	1.73	722-764
	(1.27)	(0.53)	(2.32)	(1.44)				
Portugal	.44		.54	.0054	.978	.0371	1.84	722-784
	(3.36)		(4.39)	(3.33)				
Spain	.45	.39*	.79		.878	.0464	1.67	722-774
	(1.92)	(1.49)	(3.96)					
Australia		.59	.90			.0377	1.53	722-784
		(2.23)	(constrained)					
New Zealand		.56	.90			.0539	1.34	722-771
		(1.54)	(constrained)					
Brazil	.33		.62		.994	.0514	1.05	641-764
	(6.84)		(12.78)					
Colombia	.023	.40	.92		.991	.0240	2.51	711-774
	(0.56)	(1.59)	(9.78)					
Peru	.30		.67		.944	.1298	1.10	762-782
	(0.62)		(1.25)					
Israel	.56		.31		.995	.0329	1.86	751-783
	(5.86)		(2.39)					

U.S. model is described in detail elsewhere, it will not be discussed in this section. All references to the econometric work in this section pertain only to the non-U.S. part of the model.

The Data

The raw data were taken from two of the four tapes that are constructed every month by the International Monetary Fund: the International Financial Statistics (IFS) tape and the Direction of Trade (DOT) tape. The way in which each variable was constructed is explained in brackets in Table 3. Some variables were taken directly from the tapes, and some were constructed from other variables. When "IFS" precedes a number in the table, this refers to the variable on the IFS tape with the particular number. Some adjustments were made to the raw data, and these are explained in the Appendix. The main adjustment that was made was the construction of quarterly National Income Accounts (NIA) data from annual data when the quarterly data were not available. Another important adjustment concerned the linking of the Balance of Payments data to the other export and import data. The two key variables involved in this process are D$ and S$, and, as noted in Table 3, the construction of these variables is explained in Table A-3 in the Appendix. Most of the data are not seasonally adjusted.

Note that two interest rates are listed in Table 3, the short term rate (r_{it}) and the long term rate (R_{it}). The notation for these two rates should not be confused with the notation in Table 1, where both r and R denoted short term rates. For many countries only discount rate data are available for r_{it}, and this is an important limitation of the data base. The availability of interest rate data by country is discussed in Table A-1 in the Appendix. The countries for which good short term interest rate data exist are Canada, Japan, Belgium, France, Germany, the Netherlands, and the U.K.

The variable XP_{it} is defined in Table 3 to be GNP (XF_{it}) minus government spending (XG_{it}) and exports (XE_{it}). It is taken to be a measure of the private domestic purchases of the goods and services of the country, and it is explained by equation 1 in Table 4. The implicit assumption in this interpretation of XP_{it} is that all government spending is for domestic goods and services. If some government spending is for imports, then too much has been subtracted from GNP to allow XP_{it} to be interpreted as all private domestic purchases. Data on the breakdown of government spending between domestic goods and imports are not available, and so little can be done about this problem. For most countries, especially the larger ones, this problem is not likely to be very serious, but for a few countries, it may be. Some of the values of XP_{it} for Israel, for example, were negative, and so the XP_{it} equation was not estimated for Israel. An alternative approach, which requires a more complicated model for each country, but which may be worthwhile pursuing in future work, is to disaggregate private spending into consumption and investment (both inclusive of imports) and estimate separate equations for these two variables. The GNP definition in this case is then in the more traditional form of consumption plus investment plus government spending plus exports minus imports. This alternative approach is the one taken in the U.S. model.

An Outline of the Model

Table 4 contains a complete description of the equations for country i except for the functional forms and coefficient estimates of the stochastic equations. There are up to eight estimated equations per country, and these are listed first in Table 4. Equations 1-4 are analogous to equations (1)-(4) in Table 1. Equation 5 introduces a variable that was not considered in the theoretical model, the long term interest rate. This equation is a standard term structure equation. Equations 6a and 6b are interest rate reaction functions. They are analogous to equation (21) in Table 1. The "a" denotes that the equation was estimated over the fixed exchange rate period, and the "b" denotes that it was estimated over the flexible rate period. The reason for the inclusion of the U.S. interest rate, r_{1t}, in the reaction functions was discussed in Section II.

Equation 7b determines the forward exchange rate. It is analogous to equation (22) in Table 1 and is estimated only over the flexible exchange rate period. If equation 7b is estimated for a country, then equation 8b determines the spot exchange rate. This equation is the "flexible" arbitrage condition discussed in Section II. For some countries equation 9b is estimated in place of 7b and 8b. This equation is the exchange rate reaction function and is analogous to equation (24) in Table 1.

Equations 10-18 are definitions. In equation 10b the average exchange rate for period t, $\bar{e}_{it}$, is equal to ψ_{1it} times the average of the end-of-period rates for periods $t-1$ and t. The variable ψ_{1it} is the historic ratio of $\bar{e}_{it}$ to $(e_{it} + e_{it-1})/2$, and it is taken to be exogenous in the model. This treatment means that any deviations of $\bar{e}_{it}$ from $(e_{it} + e_{it-1})/2$, which are generally quite small, are not explained within the model. Equation 11 is analogous to equation (5) in Table 1 and determines the saving of country i (i.e., the balance of payments on current account). In equation (5) interest payments and receipts are listed separately, but in equation 11 they are included in $XS\$_{it}$ and $MS\$_{it}$ along with a number of other items. These two variables are taken to be exogenous in the model, which means that interest payments and receipts are also exogenous. The data are not sufficient to allow interest payments and receipts to be made endogenous. Equation 12 determines the saving of country i denominated in local currency, and equation 13 determines the stock of securities in local currency. Equation 13 is the budget constraint for country i and is analogous to equation (6) in Table 1.[11]

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[11] A few points about the asset variable in equation 13, A^*_{it} , should be noted. First, data on this variable were constructed by summing ΔA^*_{it} from a base period value of zero. The summation began in the first quarter for which data on ΔA^*_{it} existed. This means that the A^*_{it} series is off by a constant amount each period (the difference between the true value of A^*_{it} in the base period and zero). In the estimation work the functional forms were chosen so that this error was always absorbed in the estimate of the constant term. Second, in terms of the notation in Table 1, ΔA^*_{it} for, say, country 2 is $\Delta b + \frac{1}{e}\Delta B^* + \frac{1}{e}\Delta q$. What has been done here is to aggregate all securities and international reserves into one security. This treatment, among other things, does not account for capital gains and losses on securities due to exchange rate changes, and so A^*_{it} is only an approximation to the true net security holdings even ignoring the base period error. Finally, note that A^*_{it} measures only the net asset position of the country vis a vis the rest of the world. Domestic wealth, such as the domestically owned housing stock and plant and equipment stock, is not included.

In equation 14 the GNP deflator is equal to ψ_{2it} times the export price index. The variable ψ_{2it} is taken to be exogenous, which means that the model does not explain deviations of the GNP deflator from the export price index. In equation 15 total exports as measured in the NIA is equal to ψ_{3it} times total exports as measured from the other data sources. The variable ψ_{3it} is the historic ratio of the two measures, and it is taken to be exogenous. Equation 16 is the GNP identity; it is analogous to equation (7) in Table 1. In equation 17 the value of imports as measured from the DOT data is equal to the value of imports as measured from the IFS data divided by ψ_{4it}. The variable ψ_{4it} is the historic ratio of the two and is taken to be exogenous. Finally, equation 18 relates imports in 1975 local currency to imports in 1975 dollars.

The trade and price linkages are presented in Table 5. Table 5 takes as input from each country the total value of merchandise imports in 75\$ $(M75\$_{it})$, the value of the export price index (PX_{it}), the value of the exchange rate $(\bar{e}_{it})$, and the total value of merchandise imports in 75 lc $(\bar{M}_{it})$. It gives back as output for each country the total value of merchandise exports and imputs in \$ ($X\$_{it}$ and $M\$_{it}$) and the value of the import price index (PM_{it}). These latter three variables are then used as inputs by each country. The model is solved for each quarter by iterating between the equations for each country in Table 4 and the equations in Table 5.

The share variables α_{jit} used in Table 5 are computed from the DOT data. Given the definition of $M75\$_{it}$ in Table 3, the share variables have the property that $\Sigma^1_j \alpha_{jit} = 1$, where Σ^1 denotes summation over those countries for which the share variables are defined. For some of the 64 countries, data on

PX_{jt} and/or $\bar{e}_{jt}$ do not exist, and so for these countries it is not possible to create $XX75\$_{jit}$ (and thus α_{jit}), even though data on $XX\$_{jit}$ do exist for all countries. It seemed best to define the share variables as shares of real quantities, and so this is the reason for the smaller summation. If for the computations for Table 5 α_{jit} is not defined, then $XX\$_{jit}$ is taken to be exogenous rather than determined by equation II. The summations for the nominal quantities in equations III and IV are then over all the countries.

Although one would expect α_{jit} to be a function of the price of country j's exports relative to all other prices, it is beyond the scope of this study to try to estimate these functions. What was done instead was to consider two cases, one in which the α_{jit} are exogenous and the other in which they are functions of relative prices. The basic equation that was used in the second case is presented at the bottom of Table 5. This equation states that the solution value of α_{jit} is equal to the historic value plus β times the difference between the price of country j's exports and a price index of all of country i's imports, both prices expressed as deviations from historic values. For the experiments reported below, β was taken to be -0.5. Since equations explaining the α_{jit} were not estimated, some way was needed to prevent the solution values from being too far removed from the actual data. This is the reason for the equation being expressed in deviations from the historic values. This equation has the property that if all export prices and exchange rates are predicted perfectly, then the α_{jit} will also be predicted perfectly. It is also necessary that the solution values sum to 1.0, and, as noted at the bottom of Table 5, this is true for the equation chosen.

The Estimated Equations

The estimated equations are presented in Table 6. Equations 1-5 were estimated by two stage least squares (2SLS), and the remaining equations were estimated by ordinary least squares.[12] Lagged dependent variables have been extensively used in the estimation work to try to account for expectational and/or lagged adjustment effects. Explanatory variables were dropped from the equations if they had coefficient estimates of the wrong expected sign. Variables were generally left in the equations if their coefficient estimates were of the expected sign even if the estimates were not significant by conventional standards.[13] For price and interest-rate variables, both current and one-quarter lagged values were generally tried, and the values that gave the best results were used. All the equations except 8b were estimated with a constant and three seasonal dummy variables. To conserve space, the coefficient estimates of these four variables are not reported in Table 6. A time trend was added to many of the equations to try to control for spurious correlations due to similar trends. In most cases the functional form chosen for the equations was the log form. Data limitations prevented all the equations from being estimated for all countries and also required that shorter

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[12]A list of the variables that were used as regressors in the first stage regressions for each equation for the 2SLS procedure is available upon request.

[13]There is considerable collinearity among many of the explanatory variables, especially the price variables, and the number of observations is fairly small for equations estimated only over the flexible exchange rate period. Many of the coefficients are thus not likely to be estimated very precisely, and this is the reason for retaining variables even if their coefficient estimates had fairly large estimated standard errors.

sample periods from the basic period be used for many countries. Canada through the U.K. in the table are classified by the IMF as industrial countries, and these countries make up the main part of the model. Iran through Venezuela are the primary oil exporting countries.

Equation 1 explains the real per capita purchases of the goods and services of country i by country i's private sector. Interest rates and per capita income were generally found to be significant[14] explanatory variables. The two price variables, which are expected to have coefficients with opposite signs, were generally not found to be very important. The real per capita wealth variable, $A^*_{it-1}/(PX_{it-1}POP_{it-1})$, was found to be significant for a number of countries. Equation 2 explains the real per capita merchandise imports of country i. The results for equation 2 are similar to those for equation 1 except that the price and wealth variables are on average more significant. With respect to the estimation work for equations 1 and 2, some experimentation was done to see if real, as opposed to nominal, interest rate effects could be detected. Although a number of different proxies for expected future inflation rates were tried, the nominal rates continually performed better than the constructed real rates, and so in the end only nominal rates were used.

Equation 3 explains the export price index of country i. The results for this equation provide estimates of the current and lagged effects of import prices, interest rates, and demand on export prices. Only very weak prior constraints were imposed on the lag structure for this equation. Both the current and one-quarter lagged values of import

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[14]By "significant variable" in this paper is meant a variable whose coefficient estimate is more than twice the size of its estimated standard error.

prices and interest rates were included in the equation, as well as the one- and two-quarter lagged values of the dependent variable. Also, a time trend was included in the equation to control partly for possible omitted variables with trends.

The demand variable, which is denoted XF'_{it}/POP_{it} in Table 6, was constructed as follows. First, $\log(XF_{it}/POP_{it})$ was regressed on a constant, time, and three seasonal dummy variables, and the estimated standard error, $\hat{SE}$, and fitted values, $\widehat{\log(XF_{it}/POP_{it})}$, from this regression were recorded. A new series $\widetilde{XF_{it}/POP_{it}}$, was then constructed, where

$$(3.1) \qquad \widetilde{XF_{it}/POP_{it}} = \exp[\widehat{\log(XF_{it}/POP_{it})} + k\cdot\hat{SE}] ,$$

where k is either 4, 5, or 6. XF'_{it}/POP_{it} was then taken to be:

$$(3.2) \qquad XF'_{it}/POP_{it} = 1 - \frac{XF_{it}/POP_{it}}{\widetilde{XF_{it}/POP_{it}}} .$$

If, say, k is 4, then the demand variable in (3.2) is equal to zero when the actual value of $\log(XF_{it}/POP_{it})$ is 4 standard errors greater than the value predicted by the above mentioned regression and is greater than zero otherwise.[15] Given that the log of the demand variable is used in the price equation, and assuming that this variable has the expected negative coefficient estimate, this treatment means that as the actual value of real per capita output approaches $\widetilde{XF_{it}/POP_{it}}$, the predicted price level approaches plus infinity. Given the other equations in the

[15]This is assuming that the actual value of $\log(XF_{it}/POP_{it})$ is never more than 4 standard errors greater than the value predicted by the regression. For no country was the actual value greater than 4 standard errors from the predicted value in any quarter.

model, this would never be a solution of the overall model, and so this treatment effectively bounds the output of the country from above. This is a way with limited data of putting supply constraints into the model. Each of the three values of k was tried in the estimation work, and for each value of k the current and one-quarter lagged value of the demand variable was tried. The combination that gave the best results was chosen for the final estimate of the equation.

It is clear from the results for equation 3 in Table 6 that for most countries import prices have an important effect on export prices. The estimated coefficient of the demand variable is also significant for a number of countries, and at least some slight effect of interest rates on export prices has been estimated for some countries.

There are a number of theoretical arguments that can be made for the inclusion of import prices in the export price equation, and given the seeming empirical significance of import prices on export prices, some of these should perhaps be mentioned here. In the discussion of the U.S. model in Fair (1976), it is argued that import prices may affect a firm's expectations of other firms' pricing behavior, which may in turn affect its own price decision. This "expectational" justification is consistent with the profit maximizing model of firm behavior in Fair (1974). On a more practical level, if some wages and prices in a country are indexed and if the index in part includes import prices, then import prices may directly or indirectly (through a wage effect on prices) affect domestic prices.

Equation 4 explains the per capita demand for money of country i . Both the interest rate and the income variable are generally significant in this equation. For all countries except Finland and Portugal the estimated coefficient of the interest rate was of the expected negative sign.

Equation 5 explains the long term interest rate. The explanatory variables in this equation are assumed to be proxies for expected future short term interest rates.[16] Many of the current and lagged short term rates are significant, and for all countries the inflation term has a positive coefficient estimate.

Equations 6a and 6b are the estimated interest rate reaction functions. The question of interest for these equations is whether one can find effects of inflation, money supply growth, and demand pressure on short term interest rates. The same demand variable was used for these equations for each country as was used for the price equation. Although equations 6a and 6b were estimated over fairly small numbers of observations because of the breaking up of the sample periods, the results do indicate that one can find effects of inflation, money supply growth, and demand pressure on interest rates. The estimated effects obviously vary across countries, but in general it does seem that monetary authorities in other countries "lean against the wind" in a manner similar to the way the U.S. Federal Reserve is estimated to do in Fair (1978).

It should be remembered with respect to equations 6a and 6b that good short term interest rate data exist only for Canada, Japan, Belgium, France, Germany, the Netherlands, and the U.K. The results for these countries should thus be given more weight than the results for the other countries. One interesting question to consider for these seven countries is the effect of the U.S. interest rate in the two different periods. From

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[16] See Fair (1979c) for a discussion of this equation within the context of the U.S. model.

the discussion in Section II, one would expect the U.S. rate to have less effect in the flexible exchange rate period than in the fixed rate period. This is in fact the case. For example, for the equations estimated with all the potential explanatory variables included (i.e., before some variables were excluded because of wrong signs), the t-values for the U.S. rate for the seven countries were:

Country	a Fixed Rate Period	b Flexible Rate Period
Canada	4.29	1.74
Japan	-0.89	0.02
Belgium	4.03	-0.15
France	1.76	0.04
Germany	4.33	0.86
Netherlands	3.98	0.90
U.K.	2.30	0.78

While these results are only suggestive, it does seem from them that the U.S. rate is more significant in the fixed rate period than it is in the flexible rate period in influencing the interest rates of other countries.

It should finally be noted with respect to the results for equation 6b that the U.S. rate was kept as an explanatory variable in a number of cases even though it is not expected to be as important in this equation as it is in equation 6a. As mentioned in Section II, the U.S. rate may be one of the variables influencing the decisions of the monetary authorities in other countries even in the flexible exchange rate period.

Equation 7b explains the forward exchange rate. This equation was estimated for all the industrial countries except Italy, for which there were insufficient data. The choice of the explanatory variables for this equation is based on the following argument. First, assume that the arbitrage condition (23) in Table 1 holds. In the current notation this condition is[17]

$$(3.3) \qquad e_{it} = \frac{F_{it}(1+r_{1t})}{(1+r_{it})} \; .$$

Second, assume that the forward rate equals the expected future spot rate:

$$(3.4) \qquad F_{it} = e^{e}_{it+1} \; ,$$

where superscript e denotes expectations made in period t. Substituting (3.4) into (3.3) yields:

$$(3.5) \qquad e_{it} = \frac{e^{e}_{it+1}(1+r_{1t})}{(1+r_{it})} \; .$$

Third, assume that expectations for all future periods are consistent with equation (3.5). In other words, assume that

$$(3.6) \qquad e^{e}_{it+k} = \frac{e^{e}_{it+k+1}(1+r^{e}_{1t+k})}{(1+r^{e}_{it+k})} \; , \quad k = 1, 2, \ldots ,$$

where superscript e always denotes expectations made in period t. Consider now a horizon of K periods. By successive substitutions using

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[17] The interest rates in the model are in units of percentage points, and so in an equation like (3.3) they should be divided by 100. To simplify the expressions, this was not done in the following discussion, and so for present purposes the interest rates should be thought of as being percents.

(3.6), e^e_{it+1} can be written:

$$(3.7) \qquad e^e_{it+1} = \frac{e^e_{it+K}(1+r^e_{1t+1})(1+r^e_{1t+2}) \cdots (1+r^e_{1t+K-1})}{(1+r^e_{it+1})(1+r^e_{it+2}) \cdots (1+r^e_{it+K-1})} .$$

The next step is to consider what determines e^e_{it+K}, the expected exchange rate K periods into the future. The assumption made here is that e^e_{it+K} is equal to the expected relative price level for period $t+K$:

$$(3.8) \qquad e^e_{it+K} = PX^e_{it+K}/PE^e_{1t+K} .$$

In other words, it is assumed that people expect that purchasing power parity holds in the long run. To simplify notation, let $q^e_{it+k} = (1+r^e_{1t+k})/(1+r^e_{it+k})$, $k = 1, 2, \ldots, K$. Equations (3.4), (3.7), and (3.8) can be combined to yield:

$$(3.9) \qquad \log F_{it} = \log(PX^e_{it+K}/PX^e_{1t+K}) + \log q^e_{it+1} + \log q^e_{it+2} + \cdots + \log q^e_{it+K-1} .$$

The final step is to consider what determines expectations of the future relative price level and the relative interest rate levels. A typical procedure in cases like this is to assume that future expectations are a function of current and lagged values, and this is what was done here.[18] The expected future relative price level was assumed to be a

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[18]An alternative procedure would be to use equation (3.9) directly, and use for the future expected values the future values predicted by the model. If this were done, then the predictions from the model would be consistent with the existence of rational expectations in the forward exchange markets. A procedure like this was used in Fair (1979c) for the bond and stock markets in the U.S. model. Although this procedure is now computationally feasible for many econometric models, its use is beyond the scope of the present paper.

function of the current and lagged values of the actual relative price level and of the actual relative per capita output level. Similarly, the expected future relative interest rates were assumed to be functions of the current and lagged values of the actual relative interest rates. Because of the need to conserve on degrees of freedom due to the small number of observations in the flexible exchange rate period, the lag distributions were assumed to be geometrically declining with the same decay parameter, so that the Koyck transformation could be applied. This, of course, imposes severe restrictions on the lag distributions, especially given that more than one expected future relative interest rate appears in equation (3.9). As more observations become available, it will be of interest to relax this restriction. Given these assumptions about expectations, equation (3.9) becomes

$$\log F_{it} = \gamma_1 \log(PX_{it}/PX_{1t}) + \gamma_2 \log\frac{(XF_{it}/POP_{it})}{(XF_{1t}/POP_{1t})} + \gamma_3 \log q_t + \gamma_4 \log F_{it-1} \tag{3.10}$$

where the γ coefficients are functions of the coefficients that relate current and past values to expected future values.

In the estimation work both the current and one-quarter lagged values of the relative price, output, and interest rate variables in (3.10) were tried, and the combination that appeared to give the best results was chosen. These are the estimates presented in Table 6 for equation 7b. For none of the countries did the relative interest rate variable appear to be at all important in explaining the forward rate, and so for none of the countries is it included in the final estimated equation. With respect to the relative price and output variables, it is clear from the results in Table 6 that none of their coefficients are estimated with much precision. All the estimates of the coefficient of the price variable were, however, of the expected positive sign except for France and the U.K. It turns out, as will be discussed in Section V, that some of the properties of the overall model are sensitive to whether or not the relative output variable is included in equation 7b. As can be seen from the table, the output variable was retained for Austria, Denmark, France, Switzerland, and U.K., although in none of these cases is the variable significant by conventional standards. The present results clearly show that more observations are needed before much confidence can be placed on the estimates of the forward rate equation.

Equation 8b is the estimated flexible arbitrage condition. It is estimated for the same countries for which equation 7b was estimated. If the arbitrage condition held exactly, the coefficients on $\log F_{it}$ and $\frac{1}{4}\log[(1+r_{1t}/100)/(1+r_{it}/100)]$ in this equation would both be one, the coefficients of any other variables in the equation would be zero, and a perfect fit would be obtained. The results indicate that for most countries the arbitrage condition is close to holding. For only 5 of the 13 countries were either the lagged dependent variable or the constant term significant, and most of the coefficient estimates for $\log F_{it}$ and $\frac{1}{4}\log[(1+r_{1t}/100)/(1+r_{it}/100)]$ are close to one. The fits are also quite good. The t-value of 6259.72 for the Netherlands is I believe the largest t-value I have ever obtained.

Equation 9a explains the spot exchange rate. It was estimated for countries whose exchange rate is flexible but who have insufficient forward rate data to allow equation 7b to be estimated. These are countries whose capital markets are not as well developed as the markets in the other countries and for whom the assumption of perfect capital mobility is not likely to be a good approximation. If capital is not mobile, then, as discussed in Section II, a country can manage both its interest rate and its exchange rate. Under the assumption of zero capital mobility, equation 9b can thus be thought of as an exchange rate reaction function of the government. Although the assumption of zero mobility is not exactly true for these countries, it may not be a bad approximation for many of them.

A justification for the explanatory variables in equation 9b is as follows. Assume first that the government of the country has a long run goal of keeping the exchange rate in line with purchasing power parity. Assume also that it has each period an expectation of what the "normal" or "long run" relative price level is, say $\overline{PX}^e_{it}/\overline{PX}^e_{1t}$, and that $\bar{e}_{it}$ is set to this value:

$$(3.11) \qquad \bar{e}_{it} = \overline{PX}^e_{it}/\overline{PX}^e_{1t} \ .$$

Depending on the government's views about the world economy in any given period, the normal relative price level may or may not be equal to the actual level at the time. The assumption here is in fact that the government changes its expectation slowly as the economy changes, in particular that $\overline{PX}^e_{it}/\overline{PX}^e_{1t}$ is a function of current and lagged values of the actual relative price level and of the actual relative per capita output level. As was the case for the forward rate equation, the lag distributions were assumed to be geometrically declining with the same decay parameter. Applying the Koyck transformation then yields the following equation to be estimated:

$$(3.12) \qquad \log \bar{e}_{it} = \gamma_1 \log(PX_{it}/PX_{1t}) + \gamma_2 \log\frac{(XF_{it}/POP_{it})}{(XF_{1t}/POP_{1t})} + \gamma_3 \log \bar{e}_{it-1} .$$

The estimates of equation 9b, like those of equation 7b, are not very precise, although all the estimates of the coefficient of the price variable were positive except for Australia and New Zealand. Again, more observations are needed before much confidence can be placed on the estimates of this equation.

This completes the discussion of the estimated equations. Given the poor quality of much of the data, especially for the non industrial countries, the results do not seem too bad. Effects of prices, interest rates, income, and wealth on the demands for domestic goods and imports were generally picked up, and similarly for effects of import prices, interest rates, and demand on export prices. The results for the demand for money equation and the term structure equation are quite reasonable. The results for the interest rate reaction functions also seem fairly good, especially the differential effects of the U.S. rate in the fixed and flexible exchange rate periods, although these results are based on a relative small number of observations in each period. The results for the foward rate equation 7b are not very strong, and this is where more observations are needed before much confidence can be placed on the estimates. The same is true for the exchange rate equation 9b. The results for the arbitrage equation 8b, on the other hand, seem fairly good even given the small number of observations.

IV. The Predictive Accuracy of the Model

Results that pertain to the predictive accuracy of the model are presented in Tables 7, 8, and 9. The accuracy of the model was examined for three 8-quarter periods: a fixed exchange rate period, 1970I-1971IV, and two flexible rate periods, 1974I-1975IV and 1976I-1977IV. For each of these periods both static and dynamic predictions were generated from the model, using the actual values of the exogenous variables.[19] Root mean squared errors (RMSEs) were computed for each endogenous variable for each run.

For comparison purposes an autoregressive model was also constructed in this study, and the same experiments were performed for this model as were performed for the main model. For the autoregressive model each endogenous variable was regressed on a constant, time, three seasonal dymmy variables, and its first four lagged values. The same sample periods were used for this model as were used for the main model.[20] The auto-

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[19]The model was solved by the Gauss-Seidel technique, iterating for a given quarter both within a country (the Table 4 part of the overall model) and among countries (the Table 5 calculations). No serious problems were encountered in the solution of the model, and convergence was generally quite rapid. The approximate time on the IBM 370-158 computer at Yale for one eight-quarter simulation of the complete model (including the U.S. model) was 3 minutes. The program was written to handle all equations for all 64 countries, and then the calculations for a given equation were skipped if the equations were not part of the model. This was done to make it easier to add equations to the model in the future. With respect to the fixed and flexible exchange rate periods, the program was written to use for a given country the equations that pertain to the fixed rate period up to the beginning of the sample estimation period for the flexible rate equations and then to switch to the flexible rate equations.

[20]For variables that are determined by definitions in the main model, such as real GNP (XF), the sample period used for the autoregressive model was the basic sample period for the country. Two sample periods were used for the short term interest rate, corresponding to the two sample periods in the main model for this variable.

TABLE 7. Weighted RMSEs for All Countries Except the U.S.

Notes: 1) All errors are in percentage points, except for S$.
2) Weights are GNP in 75$ in the last quarter of the period, except for S$.
3) For S$ the error is the sum of the errors for all the countries. It is in units of millions of $.

Model I = Basic Model.
Model II = Fourth order autoregressive equation with a constant, time trend, and three seasonal dummies for each variable separately.

STA = Static Prediction
DYN = Dynamic Prediction

		U.S. Endogenous											
		701-714				741-754				761-774			
Eq. No. in Table 4	Variable	Model I $\beta = -0.5$		Model II		Model I $\beta = -0.5$		Model II		Model I $\beta = -0.5$		Model II	
		STA	DYN	STA	DYN	STA	DYN	STA	DYN	STA	DYN	STA	DYN
1	XP	2.02	5.07	1.74	3.13	3.65	7.36	3.21	7.11	2.43	4.13	2.25	3.65
2	M	5.56	9.24	5.59	8.43	5.36	9.28	5.97	10.04	4.66	7.09	4.49	5.97
3	PX	1.57	2.83	2.36	6.67	2.43	5.13	3.55	10.58	2.02	4.01	1.95	4.20
4	MP*	2.59	5.34	2.76	5.25	3.26	5.12	3.03	4.72	2.78	3.86	2.44	3.76
5	R	0.29	0.42	0.28	0.43	0.42	0.97	0.52	1.18	0.40	0.84	0.42	0.97
6a,6b	r	0.58	0.90	0.61	0.85	0.73	2.88	0.73	1.02	0.81	1.54	0.73	1.37
7b	F	a	a	a	a	3.89	5.89	3.63	5.35	4.00	6.66	3.49	6.20
9b,10b	e	a	a	a	a	2.54	6.46	3.66	5.46	2.56	6.98	2.55	5.10
16	XF	1.46	3.46	1.31	1.97	2.04	4.42	1.78	3.22	1.46	2.35	1.20	1.74
19	X$	2.25	4.94	6.53	12.45	2.55	6.60	9.03	11.82	1.89	3.45	5.66	7.23
20	M$	4.46	7.70	7.58	18.91	4.88	8.52	8.74	13.51	3.99	6.53	5.10	6.28
21	PM	1.03	1.60	4.05	11.76	2.03	5.41	5.37	16.15	2.23	5.54	2.59	5.57
11	S$	2784.	4327.	4975.	7568.	6929.	11227.	14107.	20171.	7169.	9506.	11775.	14127.

		U.S. Endogenous						U.S. Exogenous					
		701-714		741-754		761-774		701-714		741-754		761-774	
Eq. No. in Table 4	Variable	Model I $\beta = 0$		Model I $\beta = 0$		Model I $\beta = 0$		Model I $\beta = -0.5$		Model I $\beta = -0.5$		Model I $\beta = -0.5$	
		STA	DYN	STA	DYN	STA	DYN	STA	DYN	STA	DYN	STA	DYN
1	XP	2.01	5.07	3.63	7.35	2.41	4.20	2.02	4.95	3.67	7.40	2.42	4.23
2	M	5.55	9.33	5.33	9.21	4.61	6.97	5.56	9.18	5.33	9.01	4.65	7.16
3	PX	1.57	2.85	2.46	5.43	2.01	3.82	1.57	2.88	2.43	5.27	2.02	4.00
4	MP*	2.60	5.38	3.25	5.12	2.79	3.94	2.58	5.28	3.26	5.21	2.78	3.92
5	R	0.29	0.43	0.41	1.01	0.39	0.83	0.28	0.42	0.41	0.96	0.39	0.35
6a,6b	r	0.58	0.90	0.73	2.92	0.81	1.52	0.56	0.90	0.72	2.85	0.81	1.54
7b	F	a	a	3.88	5.80	3.99	6.52	a	a	3.87	6.31	3.99	6.43
9b,10b	e	a	a	2.52	6.40	2.54	6.70	a	a	2.51	7.13	2.57	6.67
16	XF	1.45	3.46	1.97	4.31	1.38	2.30	1.46	3.29	2.06	4.42	1.43	2.41
19	X$	2.40	5.25	3.35	7.63	2.49	4.95	1.87	3.82	2.03	4.81	1.59	3.61
20	M$	4.45	7.81	4.91	8.64	3.98	6.68	4.47	7.69	4.86	8.24	3.97	6.51
21	PM	1.06	1.63	2.02	5.51	2.20	5.24	1.02	1.60	2.00	5.97	2.22	5.32
11	S$	2832.	4350.	7518.	12591.	7882.	10594.	2669.	4104.	6797.	10839.	7037.	9698.

a = Fixed exchange rate period for almost all countries.

TABLE 8. RMSEs for the Individual Countries: Dynamic Simulation, 741-754

I = Model I (β = -0.5) . II = Model II.
Errors are in percentage points, except for S$. For S$ the errors are in millions of $.

	XP		M		PX		MP*		R		r		F		$\bar{e}$		XF		X$		M$		PM		S$	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Canada	3.4	2.0	7.3	4.9	5.8	9.7	2.8	4.0	0.5	0.8	1.1	1.0	4.3	1.7	3.6	1.6	2.5	2.0	9.7	8.7	6.4	14.4	3.0	12.5	461	621
Japan	6.4	5.2	5.9	13.4	2.1	13.6	2.9	2.8			4.4	0.8	4.1	4.9	4.5	4.2	5.1	4.3	6.2	13.7	4.4	12.6	3.3	24.5	1156	1292
Austria	2.4	4.6	8.3	10.3	6.8	8.3	8.1	3.1			0.4	0.9	7.9	6.0	7.2	6.0	2.2	2.8	6.1	9.7	8.9	11.2	7.1	8.5	94	140
Belgium	10.1	10.5	10.3	9.5	9.2	9.6	2.3	2.4	0.9	0.5	3.6	1.8	8.9	4.9	7.3	5.3	3.6	2.7	7.9	9.9	10.7	8.9	7.2	11.7	268	170
Denmark	11.4	14.0	6.9	8.0	3.2	7.5	9.2	6.7	0.9	1.8	1.7	0.3	5.4	4.0	4.7	5.0	6.4	5.4	6.4	5.7	5.6	7.5	3.5	8.6	64	189
France	4.2	4.8	4.0	9.6	3.5	9.9	3.6	3.9	0.9	1.1	3.2	1.4	6.0	5.2	5.1	7.4	3.1	1.9	7.0	7.6	3.0	12.1	5.1	17.3	722	898
Germany	9.3	6.4	11.0	7.2	2.0	8.0	2.7	2.3	1.5	1.1	4.3	1.3	5.6	5.8	4.7	5.2	5.5	2.7	8.0	10.8	9.6	6.8	4.3	8.8	1231	1140
Italy	2.4	7.0	9.5	12.7	10.7	11.3	10.4	10.4	0.6	1.6	2.1	1.3			13.1	9.3	2.7	2.0	4.2	11.1	8.6	14.7	13.7	18.4	576	1224
Netherlands	15.1	22.0	12.9	7.2	11.6	11.2	19.1	4.6	2.0	1.0	6.7	2.1	11.5	5.9	9.7	5.6	6.0	2.7	7.1	11.7	15.0	11.0	11.6	14.9	644	224
Norway	6.7	6.1	15.0	5.3	2.9	11.5	5.8	5.4	0.3	0.5	0.3	0.3	4.6	5.7	4.0	5.0	4.1	1.9	4.8	10.9	13.2	11.3	2.1	7.8	235	301
Sweden	9.2	5.8	10.4	4.9	3.0	10.5	7.8	10.2	0.7	0.3	2.3	0.5	3.9	3.8	3.1	5.5	5.6	1.9	4.5	11.6	9.1	14.9	2.2	11.9	214	290
Switzerland	5.2	7.9	12.2	13.5	4.7	6.8	5.3	7.0	0.5	0.6	0.6	0.9	8.0	6.5	7.4	6.4	4.4	6.5	4.5	9.8	14.1	24.5	8.8	6.2	339	320
U.K.	6.0	8.0	5.4	6.4	0.9	10.2	3.1	3.5	0.9	2.3	1.7	0.8	8.4	8.5	7.9	7.4	4.7	3.1	3.1	6.9	4.8	9.8	7.7	5.5	364	1219
Finland	4.5	3.4	8.7	8.5	2.7	17.1	8.8	11.2			0.9	0.4	5.3	5.0	4.3	4.2	3.5	2.6	4.5	13.3	6.4	23.8	3.0	15.1	126	386
Greece	5.7	11.7	12.2	16.9	6.0	7.8	7.0	4.2			1.5	1.4					4.3	8.0	7.8	10.2	14.6	11.3	2.8	19.6	119	160
Ireland	9.5	19.7	13.5	10.5	5.3	2.9	2.4	6.7			1.2	0.5			5.8	6.4	4.2	9.1	6.1	7.0	11.3	12.6	4.0	12.0	72	120
Portugal	11.7	8.3	25.1	22.4	19.5	6.7	10.3	4.2	0.1	1.6	1.8	1.2			16.4	6.2	7.6	7.2	9.8	17.4	26.4	26.1	18.9	10.4	218	238
Spain	3.3	3.1	6.3	4.6	11.3	9.1	6.0	3.8			0.2	0.3			14.4	2.5	3.0	2.9	4.8	11.5	5.7	20.8	14.3	14.3	167	737
Yugoslavia	3.3	3.1	4.1	6.2													2.2	3.3	3.6	7.5	4.4	13.9	1.7	19.6	71	195
Australia	5.3	3.2	12.9	7.6	5.1	7.3	3.7	8.7	0.6	0.4	2.1	0.6			3.1	2.1	4.0	1.7	2.7	4.5	11.5	12.2	4.3	23.9	233	413
New Zealand	0.7	2.7	10.1	14.8	13.0	23.3	9.3	7.8	0.3	0.4	0.4	0.4			6.4	4.1	0.8	0.6	13.7	23.8	10.7	21.3	5.1	15.5	68	167
South Africa	12.7	1.9	26.5	12.6	8.2	7.8	2.2	6.1	0.5	0.4	1.0	0.7					7.7	3.3	6.5	17.1	25.2	14.1	3.3	8.8	354	771
Iran	23.2	25.9	6.6	15.0			18.3	11.0			1.5	0.5					9.0	1.6	4.4	35.4	10.1	23.4	2.2	3.2	391	1554
Libya	75.8	76.0	4.3	10.8													7.0	20.6	6.0	31.4	5.5	21.2	2.3	4.3	111	678
Nigeria	16.7	12.1	6.5	9.6													10.4	13.4	6.0	13.9	6.0	10.8	2.5	3.5	151	344
Saudi Arabia	26.0	27.8	10.0	15.8													3.8	6.5	4.5	30.1	16.3	37.6	2.0	4.2	245	2470
Venezuela	36.9	30.7	55.5	10.1													15.4	1.1	6.3	15.5	54.0	16.4	1.4	4.8	534	499
Argentina			19.2	22.1													0.7	4.7	12.0	26.4	25.3	26.1	2.3	176.0	113	277
Brazil	1.3	1.8	8.5	8.6	13.8	15.5									8.5	6.7	1.3	2.2	9.5	11.2	8.5	16.1	8.5	8.4	202	522
Chile	37.7	15.7	112.8	105.0													26.9	12.0	9.8	14.1	138.8	36.3	12.9	66.9	377	118
Colombia	3.9	2.4	16.6	11.8											8.2	2.7	3.3	0.8	22.5	17.2	19.7	12.1	7.5	3.0	44	122
Mexico	3.0	3.3	3.6	8.4													2.2	2.3	11.0	8.7	4.4	12.9	1.0	17.3	109	212
Peru	11.1	5.2	21.8	23.5													9.0	3.0	10.6	18.3	24.5	32.8	1.6	6.5	95	229
Egypt	8.7	6.5	23.7	5.7													4.7	3.4	9.0	18.1	31.8	46.4	1.7	6.8	208	633
Israel			7.7	8.5	19.0	23.5									20.1	10.4	0.8	1.7	10.6	10.6	5.3	10.9	15.0	20.9	84	217
Syria	9.0	11.5	20.4	15.5	19.4	28.0											4.7	10.6	20.1	33.3	19.7	22.9	2.6	15.9	60	63
China	15.0	14.3	18.1	15.2	6.1	7.8	15.9	18.9			1.4	1.6					5.4	12.4	9.2	33.1	14.8	19.9	6.5	9.7	314	290
Korea	5.8	4.0	11.3	18.0	7.3	5.0	7.1	9.5			0.8	0.8					2.8	5.2	8.1	27.8	11.1	15.1	2.8	16.1	170	378
Malaysia	3.5	2.9	8.1	8.0	15.0	9.0											3.1	3.9	10.1	7.8	8.3	9.0	1.6	6.1	69	108
Phillippines	7.1	3.6	7.3	5.4	15.2	17.7	2.0	3.8									6.9	3.5	12.1	18.7	8.0	22.0	2.1	20.0	76	144
Thailand	8.1	6.0	12.1	17.8	5.0	8.2	6.1	4.7			0.3	0.8					5.7	3.7	7.4	17.7	10.8	9.6	2.5	16.1	80	97
Weighted Total	7.36	7.11	9.28	10.04	5.13	10.58	5.12	4.72	0.97	1.18	2.88	1.02	5.89	5.35	6.46	5.46	4.42	3.22	6.60	11.82	8.52	13.51	5.41	16.15	11227	20171

TABLE 9. RMSEs for the U.S.

All errors are in percentage points. ROW = Rest of World.

	ROW Endogenous (Model I, $\beta = -0.5$)						ROW Exogenous					
	701-714		741-754		761-774		701-714		741-754		761-774	
	STA	DYN	STA	DYN	STA	DYN	STA	DYN	STA	DYN	STA	DYN
Nominal GNP	0.46	1.46	0.87	2.32	0.73	0.87	0.46	1.60	0.88	2.06	0.68	0.64
Real GNP	0.48	0.47	0.94	2.73	0.86	1.16	0.46	0.43	0.90	2.29	0.79	1.03
GNP Delfator	0.29	1.05	0.34	0.65	0.38	1.45	0.32	1.23	0.31	0.54	0.35	0.85
Money Supply	1.21	3.74	1.18	0.97	0.69	1.01	1.21	3.78	1.18	0.98	0.69	0.99
Real Value of Imports	2.40	4.71	4.49	8.16	2.30	4.30	2.41	4.51	4.45	7.45	2.27	3.74
Import Price Deflator	0.58	1.02	1.20	1.36	0.83	2.22	a	a	a	a	a	a
Bill Rate	0.54	0.64	0.60	0.84	0.25	0.36	0.55	0.64	0.59	0.74	0.25	0.35
Real Value of Exports	0.85	0.84	0.86	4.10	1.11	1.40	a	a	a	a	a	a

a = variable is exogenous.

regressive model consists of a set of completely unrelated equations. The predictions and errors in one equation have no effect on any of the other equations.

For the results in Table 7 a weighted average of the RMSEs across all countries except the U.S. was taken for each variable. The RMSEs were weighted by the ratio of the country's real GNP (in 75$) in the last (i.e., eighth) quarter of the prediction period to the total real GNP of all the countries. This provides a summary measure of the overall fit of the model with respect to each variable. The RMSEs of the individual countries are presented in Table 8 for one run, the dynamic prediction for the period 1974I-1975IV. This is the period of the large increase in the price of oil by OPEC, and it is generally the worst fitting period for the model. The RMSEs for the U.S. are presented in Table 9.

The results in Tables 7 and 8 do not provide a rigorous comparison of the accuracy of the two models because the models are based on different sets of exogenous variables. For the autoregressive model (Model II) there are no exogenous variables except the constant term, time, and the seasonal dummy variables. For the main model (Model I), on the other hand, there are some non-trivial exogenous variables, namely the government spending variable of each country (XG_{it}) and the price of exports of the oil exporting countries. Because of this difference in the degree of endogeneity of the two models, the results in the two tables are merely meant to provide a rough indication of Model I's accuracy relative to that of Model II.[21]

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[21] A method of comparing the accuracy of models that does take into account the different degrees of endogeniety of models (as well as their possible misspecification) is presented in Fair (1980). This method is, however, somewhat expensive to use, since it is based on extensive reestimation and stochastic simulation, and it is beyond the scope of the present

The basic set of results in Table 7 is for $\beta = -0.5$. (See Table 5 for the definition of β .) Results for $\beta = 0.0$ are also presented, however, in order to examine the sensitivity of the model's accuracy to alternative values. Results are also presented in Table 7 for the case in which the U.S. is exogenous, i.e., for the case in which the U.S. variables that affect the other countries are taken to be exogenous.

The following conclusions can be drawn from Table 7. The accuracy of Model I is not very sensitive to the two different values of β and to whether or not the U.S. is treated as exogenous. Model I is on average considerably more accurate than Model II for the price variables, PX and PM . This is due in part, of course, to the treatment of the price of exports of the oil exporting countries as exogenous in Model I. Model I is also on average more accurate than Model II for the export and import variables, X$ and M$, and for the balance of payments variable, S$. The two models are about the same with respect to the interest rates, r and R , although the dynamic predictions of r for the second period are noticeably worse for Model I. The static predictions of the forward and spot exchange rates, F and $\bar{e}$, are of about the same degree of accuracy for the two models, but the dynamic predictions are slightly more accurate for Model II. For the remaining variables, XP , M , MP* , and XF , the results for the two models are fairly close, although Model II is always at least slightly more accurate for XP and XF .

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study to try to use it. The method has been used to compare the accuracy of the U.S. model to that of an eighth-order autoregressive model, and these results are presented in Fair (1980). Because of this, it seemed unnecessary in the present case to do another comparison of the U.S. model and an autoregressive model, and this is the reason only results for the main model are presented in Table 9 for the U.S.

The individual RMSEs in Table 8 are generally larger for the smaller countries, which is as expected given the poor quality of much of the data for the smaller countries. The small countries have, of course, a small effect on the weighted RMSEs in Table 7, and it makes little difference to the fit and properties of the overall model whether or not these countries are included. With respect to the results for the U.S. in Table 9, the main conclusion to be drawn from them is that the fit of the U.S. model is not very sensitive to whether or not the U.S. model is included in the overall model, i.e., to whether or not the rest of the world is taken to be exogenous in the U.S. model.

To conclude, it appears from the results in Tables 7 and 8 that the present model is on average about as accurate or slightly more accurate than the autoregressive model. With better data in the future and more work on the models of the individual countries, one would hope to improve the model's accuracy relative to that of the autoregressive model. In the meantime, it would seem from the current results that any model that is not on average as accurate as an autoregressive model is not likely to be as accurate as the present model.

V. The Properties of the Model

A useful way to examine the properties of the model is to consider the results of changing various exogenous variables. The results of two of these experiments are presented in Table 10, one an increase in the purchase of U.S. goods by the U.S. government and the other an increase in the purchase of German goods by the German government. These two experiments were performed both in a fixed exchange rate period (beginning in 1970I) and in a flexible rate period (beginning in 1976I). The effects

TABLE 10. Percentage Change in the Variable After Four Quarters Induced by a Sustained one Percent Autonomous Increase in U.S. or German Real Income

a = Initial change in 1970I (fixed exchange rates).
b = Initial change in 1976I (flexible exchange rates).
NA = Not readily available from the computer output.

	Private Demand XP		Imports M		Export Price PX		Money Supply MP*		Interest Rate r		Forward Rate F	Spot Rate e	Real GNP XF		Exports X$		Import Price PM	
	a	b	a	b	a	b	a	b	a	b	b	b	a	b	a	b	a	b
U.S. Increase																		
U.S.	NA	NA	3.09	3.15	.38	.27	-.04	-.18	.69	.80			1.43	1.71	.41	.38	.27	.31
Canada	.05	.21	.81	.90	.75	.72	-1.66	-.40	.81	.46	.18	.22	.31	.46	2.41	2.29	.27	.50
Japan	.13	.11	.10	.05	.11	.36	-.16	.27	.08	.09	.06	.22	.19	.16	1.04	.82	.20	.68
Austria	-.12	-.06	-.40	-.17	.13	-.58	-.06	-.36	.18	-.01	-1.61	-1.11	-.08	-.10	.16	.48	.11	-.83
Belgium	-.16	.02	-.38	-.00	.37	.39	-.87	.05	.58	.06	.06	.30	-.14	-.01	.29	.09	.17	.58
Denmark	.06	.31	.03	.45	.07	-.83	.05	-.45	.01	.00	-2.15	-1.66	.07	.06	.27	.78	.13	-1.40
France	-.11	-.03	-.27	-.03	.20	.15	-.16	.04	.34	.01	-.27	-.07	-.09	-.03	.19	.19	.16	.24
Germany	-.29	-.24	-.42	-.34	.08	.17	-.66	-.23	.39	.31	-.05	.03	-.15	-.12	.25	.21	.20	.36
Italy	-.00	-.04	.02	-.04	.13	-1.09	-.11	-.31	.15	-.10		-2.12	.01	-.16	.27	.66	.14	-1.89
Netherlands	-.25	-.24	-.37	-.32	.32	.44	-2.69	-.94	.67	.50	.17	.20	-.19	-.14	.18	.15	.17	.44
Norway	.00	.01	-.02	.16	.22	.97	-.28	.15	.07	.09	.50	.70	-.03	.03	.31	.55	.14	.97
Sweden	-.09	.03	-.03	.06	.08	.30	-.20	.06	.29	.03	.01	.19	-.03	.06	.18	.34	.14	.52
Switzerland	-.02	-.06	-.26	-.85	.06	-.28	-.10	-.13	.12	.17	-1.62	-1.16	.02	-.16	.26	.69	.14	-.85
U.K.	-.14	-.21	-.01	-.10	.08	-.22	-.42	-.41	.30	.37	-1.14	-.84	-.05	-.17	.39	.59	.18	-.53
Finland	.03	.12	.08	.26	.10	.60	.07	.26	.00	.03	.06	.41	.03	.12	.21	.49	.12	.70
German Increase																		
U.S.	NA	NA	.11	.04	.03	.01	.00	-.00	.01	.01			.02	.02	.43	.35	.21	.07
Canada	.03	.02	.09	.07	.09	.04	-.02	.00	.02	.01	.01	.01	.06	.04	.33	.19	.09	.04
Japan	.03	.04	.02	.03	.05	.02	.05	.04	.02	.02	.00	-.00	.04	.05	.29	.25	.10	.03
Austria	.06	.08	.30	.35	.73	.71	.57	.59	.04	.05	.49	.38	.20	.21	1.87	1.23	.76	.75
Belgium	.09	-.00	.62	.33	.45	.39	.09	-.02	.08	.23	.18	.07	.44	.26	1.82	1.16	.48	.31
Denmark	.23	.20	.10	.09	.23	.29	.17	.24	.03	.04	.33	.28	.26	.25	1.00	.83	.43	.51
France	.16	.11	.24	.10	.29	.18	.11	.06	.02	.15	.02	-.01	.23	.16	1.44	.88	.50	.21
Germany	2.98	2.14	5.04	3.57	1.37	.90	1.59	.96	.92	1.21	.42	.16	2.79	2.05	1.35	.57	.22	.26
Italy	.12	.14	.30	.38	.24	.35	.13	.15	.00	.04		.39	.21	.25	1.41	.76	.43	.60
Netherlands	.07	-.15	.99	.65	.30	.37	.46	-.46	.00	.41	.30	.17	.53	.36	1.95	1.27	.47	.39
Norway	.04	.03	.39	.32	.34	.37	.21	.20	.02	.01	.25	.19	.15	.12	1.34	.71	.33	.37
Sweden	.06	.05	.28	.27	.23	.13	.07	.04	.01	.04	.03	.02	.16	.15	.93	.67	.44	.23
Switzerland	.03	.03	.39	.39	.22	.16	.01	.00	.01	.02	.17	.13	.17	.17	1.08	.76	.55	.39
U.K.	.05	.08	.08	.11	.09	.08	.04	.08	.01	.02	.05	.04	.09	.12	.53	.48	.22	.18
Finland	.13	.13	.36	.38	.36	.20	.21	.14	.02	.02	.03	.02	.19	.18	.99	.70	.40	.22

of these changes on some of the key variables in the model are presented in Table 10 for the main countries in the model. Each number in Table 10 is the percentage difference between the four-quarter-ahead predicted value of the variable before and after the change divided by the percentage change in autonomous income.[22]

It should be stressed that the following discussion of the results in Table 10, and of the properties of the model in general, is somewhat loose. Reference is sometimes made to a change in one endogenous variable "leading to" or "resulting in" a change in another endogenous variable, which is not, stictly speaking, correct because the model is simultaneous. It is much easier to discuss the properties of the model by using these phrases, and little is lost in doing so as long as one is aware how they are being used.

Consider first in Table 10 the U.S. increase in the fixed rate period. The increase in U.S. government spending increased U.S. income, which in turn increased the U.S. demand for imports. The increase in the U.S. demand for imports increased other countries' exports, which in turn increased their income and demand for imports. This is the standard trade multiplier effect. The increase in U.S. income also led to an increase in the U.S. price level, which increased other countries' import

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[22]More precisely, each number in the table is $[(\hat{\hat{y}}_{jt} - \hat{y}_{jt})/\hat{y}_{jt}]/[\Delta XG_{it}/\widehat{XF}_{it}]$, where $\hat{y}_{jt}$ is the four-quarter-ahead predicted value of y_{jt} before the change (from a dynamic simulation beginning in quarter t-3 using the actual values of all exogenous variables), $\hat{\hat{y}}_{jt}$ is the four-quarter-ahead predicted value of y_{jt} after the change, ΔXG_{it} is the change in government spending (either U.S. or German) in quarter t, and $\widehat{XF}_{it}$ is the four-quarter-ahead predicted value of real GNP (either U.S. or German) before the change.

prices. This led to an increase in other countries' domestic prices (and thus their export prices), which resulted in further increases in import prices of other countries (including the U.S.). This is what might be called a "price multiplier" effect. There is thus both a trade multiplier effect and a price multiplier effect in the model: import prices affect export prices and vice versa as well as imports affecting exports and vice versa.

The other important effect in this experiment is the interest rate effect. The increase in U.S. income and prices led to an increase in the U.S. interest rate through the reaction function of the U.S. Federal Reserve. This offset some of the increase in U.S. income that would otherwise have occurred and also led to an increase in other countries' interest rates. If capital had been assumed to be perfectly mobile in the model, then the interest rates in the other countries would have gone up by the same amount as the U.S. rate. Since, as discussed in Sections II and III, this restriction was not imposed on the model, the interest rates in the other countries generally increased less than the U.S. rate. Interest rates did, of course, go up, and this worldwide increase in interest rates offset some of increase in world income that would otherwise have occurred. In fact, for some countries the change in real GNP (XF) in Table 10 is negative, and this is primarily due to the increase in interest rates. The interest rate effect in the model is thus quantitatively important and over time offsets much of the trade multiplier effect.[23] Finally, note for this experiment that the demand

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[23] Some multiplier results for other multicountry econometric models are presented in Tables 1 and 2 in Fair (1979b), and these provide a rough basis of comparison for the results from the present experiment (U.S. increase in a fixed exchange rate period). In general, the present income multipliers are smaller and the price multipliers are larger than those of the other models. This is, of course, as expected, since the other models are primarily trade multiplier models and so have weak or non-existent price multiplier and interest rate effects.

for money (MP*) in most countries fell in response to the U.S. increase. This is also primarily due to the increase in interest rates.

Consider next the German increase in the fixed rate period. The trade and price effects are similar to the effects for the U.S. increase in that exports and prices increased. The main difference in the German case concerns the interest rate. If capital were perfectly mobile and if the U.S. Federal Reserve were assumed to be the monetary authority setting the (world) interest rate, then the only change in interest rates that would occur in response to the German income increase would be as a result of the Federal Reserve responding through its reaction function to the increase in U.S. income and prices induced by the German increase. As noted above, the assumption of perfect mobility was not imposed on the model, and the German interest rate did rise much more than any of the other countries' interest rates in response to the German income increase. As can be seen from the estimates of equation 6a for Germany in Table 6, the German monetary authorities are estimated to respond to German inflation and demand, as well as to the U.S. rate, in setting the German rate. The interest rates in the other countries did not rise very much in this case, which is due in large part to the fact that the U.S. rate did not rise very much. Even though capital is not assumed to be perfectly mobile, the U.S. is still the leader with respect to interest rates in the fixed exchange rate regime, and so in general interest rates in other countries will not change very much unless the U.S. rate does. The exception, of course, is when a large shock occurs in a particular country, as is the case for Germany in the present experiment.

Since interest rates did not increase very much in the German experiment, there was little offset to the increases in output from the trade multiplier effect. In fact, real GNP (XF) rose in all countries, contrary to the case for the U.S. experiment.

The results for the flexible exchange rate period are more difficult to describe. They are also, as will be seen, sensitive to the specification of the forward exchange rate equation (equation 7b in Table 6). Given that the estimates of this equation are not very precise, the results for the flexible rate period in Table 10 must be interpreted with considerable caution.

One key difference between the fixed and flexible rate periods is that the U.S. interest rate has much less effect on the other countries' interest rates in the flexible rate period. This can be seen from the results in Table 10 for the U.S. experiments, where the increases in the other countries' interest rates are generally smaller in the flexible rate period. There is thus less interest-rate offset to the output increases in the flexible rate period.

The other key difference between the two periods is, of course, the endogeneity of the spot and forward exchange rates in the flexible rate period. As can be seen from equation 7b in Table 6, the forward rate in a country responds either to the difference between its price level and the U.S. price level or to the difference between its output level and the U.S. output level (or to both). It turns out for the U.S. experiment that the forward rate response (and thus the response of a number of other variables) is sensitive to which of these two variables is in the forward rate equation. The reason for this sensitivity, which is important to know for purposes of understanding the properties of the model, will now be discussed.

First, the following three effects in the model should be kept in mind. (1) An increase in the U.S. interest rate relative to other countries' interest rates results, other things being equal, in an increase in other countries' spot exchange rates through the arbitrage equation 8b. (Remember that an increase in a country's exchange rate is a depreciation of its currency.) (2) An increase in a country's forward rate also results, other things being equal, in increase in its spot rate through the arbitrage condition 8b. (3) An increase in a country's spot rate increases its import price level, which in turn (and over time) increases its domestic price level.

Consider now the effects of the U.S. experiment. The increase in U.S. government spending increased U.S. output more than it did other countries' output. This then had a negative effect on the forward rates of those countries for which the difference in output is the main variable in the forward rate equation. (These countries are Austria, Denmark, France, Switzerland, and the U.K.) According to the theory behind the specification of the forward rate equation, the increase in U.S. output relative to other countries' output led people to expect that U.S. prices would rise in the future relative to other countries' prices, which in turn led to an appreciation of the future values of the other countries' currencies. The fall in the forward rates for these five countries led to a fall in the spot rates. The spot rates fell less than the forward rates because of the increase in the U.S. interest rate relative to the other countries' interest rates. Except for France, the fall in the spot rates resulted in a fall in import prices, which in turn resulted in a fall in domestic prices. (For France, the fall in the spot rate was quite small, and other effects on import prices dominated the spot rate effect.)

The increase in U.S. government spending also increased the U.S. domestic price level. This effect (after four quarters) was not very large, however, which was due in part to the fact that the initial change was from a relatively low level of output. The small response of the U.S. price level meant that the forward rates did not change very much for those countries for which the difference in the price levels is the main variable in the forward rate equation. (These countries are Canada, Japan, Belgium, Germany, the Netherlands, Norway, Sweden, and Finland.) In fact, for all these countries except Germany, the forward rates actually rose (a depreciation of the future values of the currencies). What happened in these cases, speaking loosely, is that the interest-rate effect on the spot rate dominated the forward-rate effect on the spot rate. The increase in the U.S. interest rate relative to the other countries' interest rates led to a rise in the spot rates, which led to a rise in the import price levels and then the domestic levels. For all the above countries except Germany, the increase in the domestic price level was larger than the increase in the U.S. domestic price level, which meant a rise in the forward rate. This last line of reasoning is, of course, not precise because the forward rate also affects the spot rate, but it should convey the general idea. At any rate, except for Germany, the net effect on the forward rate was positive. For Germany, the forward rate fell slightly and the spot rate rose slightly.

To summarize this discussion, there are two effects on the spot rate (through the arbitrage condition): the interest-rate effect and the forward-rate effect. For the first five countries mentioned above, the forward-rate effect dominated the interest-rate effect because the forward rates changed substantially in response to the large relative increase in U.S. output. For the other countries, the interest-rate effect dominated the forward-rate effect because the forward rates did not change very much. The forward rates did not change very much because the increase in the U.S. price level in response to the U.S. government spending increase was not very large. As just seen, the forward rates may in fact rise as a result of the U.S. spending increase if the (indirect) effect of the higher U.S. interest rate on the other countries' domestic price levels (through the spot-rate, import-price effect) is large enough. It should be clear from the above discussion that the properties of the model are sensitive to the specification of the forward rate equations and thus that more precise estimates of these equations are needed before much confidence can be placed on the present results.[24]

Consider finally in Table 10 the German increase in the flexible rate period. There is obviously less effect in general on the spot and forward rates (the prices of the currencies relative to the dollar) in this case than in the U.S. case since the initial shock was in Germany. The increase in the German price level was larger than the increase in the U.S. price level, and this led to an increase in the German forward rate (a depreciation of the future value of the D. Mark). The German spot rate did not rise as much as the forward rate because of the increase in the German interest rate relative to the U.S. rate. The forward rates of the other countries, except Japan, increased relative to the dollar. This was due to the smaller price and output response in the U.S. than in the other countries. As was the case for the German increase in the

[24]This sensitivity also increases interest in the possible alternative treatment of the forward rate equation discussed in ftn. 18, p. 43, namely the assumption that the relevant future expectations are rational.

fixed rate period, import prices of all countries increased and the real output of all countries increased.

This completes the discussion of the results in Table 10. There is obviously much more that could be said about these experiments, especially since not all the countries in the model are listed in Table 10, but the present discussion has covered most of the main features of the model. For those who are interested in the results for particular countries, the model is available for use by others. (See the Appendix for a description of the various tapes that are available.) The program that solves the overall model is written in such a way that one can easily replace a model of a particular country with another (perhaps larger) model. In this way one can examine both the sensitivity of the properties of the overall model to alternative country models and the sensitivity of the properties of individual country models to inclusion in the overall model.

To conclude this section, two other experiments with the model will be briefly discussed. The first experiment was a change in the price of exports of the oil exporting countries. This led, as expected, to an increase in other countries' domestic prices through the price multiplier effect. The monetary authorities of the various countries responded (through their interest rate reaction functions) to the higher rates of inflation by raising interest rates. This then led to a general contraction in output in the world. The contraction in output was exacerbated by the fact that the oil exporting countries saved a considerable amount of their increased revenue, which resulted in a net decline in the demand for imports in the world.[25] These general effects occurred both in the fixed and flexible exchange rate periods, although there were significant quantitative differences in the response of many variables between the two periods. Other than these effects, there appeared to be no insights into the properties of the model to be gleaned from this experiment that were not already known from the experiments in Table 10, and so for present purposes no more needs to be said about it.

The second experiment was the same as the U.S. experiment in Table 10 (an increase in U.S. government spending) except that the rest of the world was taken to be exogenous. In other words, only the U.S. model was used for the experiment. From the results for the two U.S. experiments, one can examine the sensitivity of the properties of the U.S. model to inclusion in the overall model. The U.S. output response was not very sensitive to the treatment of the rest of the world. This is, of course, not surprising, given the results in Table 10, because the output response of the other countries was not very large (since the interest-rate effect offset much of the trade multiplier effect). The U.S. price level response was smaller when the rest of the world was taken to be exogenous. In this case there was no feedback from the price increases in the rest of the world to the U.S. price level, and so the increases in the U.S. price level were smaller. In other words, there was no price multiplier effect on the U.S. in this case. This

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[25] The higher price of exports of the oil exporting countries results in an increase in the balance of payments of these countries (equation 11 in Table 4), which means an increase in their assets (equations 12 and 13 in Table 4). The increase in assets then leads to an increase in their demand for imports (equation 2 in Table 6). This increase is not, however, large enough to make up for the decrease in the demand for imports by the other countries, at least in the experiments that were run.

general conclusion about the output and price level responses held for both the fixed and flexible rate periods.

As a final comment, it would be possible to compare the properties of the present model to the properties of Model A in Fair (1979a). Model A is a "quasi-empirical" two-country model obtained by linking the U.S. model to a model exactly like it. This comparison may be of interest in future work, since one may gain some insights into the properties of the present model from trying to run comparable experiments for the two models. In general, however, I look on Model A as merely an intermediate step between the general theoretical model in Fair (1979a) and the present econometric model.

VI. Conclusion

The econometric model developed in this study provides quantitative estimates of the trade, price, and interest-rate linkages among countries. The results of the experiments in Section V provide some information on these linkages, although there are clearly many other experiments that could be run to learn more about them. In future work, it will be of interest to examine the properties of the model further and in particular to examine the sensitivity of the properties to alternative specifications of some of the equations. As more observations become available under flexible exchange rates, it should be possible to get better estimates of the exchange rate equations, and it will be interesting to see how the new estimates change the properties of the current version. It is obvious from the current version that the price and interest-rate linkages are quantitatively quite important, so that any model based primarily on trade linkages is not likely to be a very good approximation of the world economy.

DATA APPENDIX

This Appendix has two main purposes. The first is to explain the construction of the data base that was used for the model, and the second is to describe some tapes that are available that can be used by others to experiment with and change the model. As noted in Section V, it should be possible after receiving the tapes to replace one or more of the models of the individual countries with one's own model or models and then run experiments with the new version. In this way one can examine both the sensitivity of the properties of the overall model to the inclusion of alternative models of specific countries and the sensitivity of the properties of specific country models to inclusion in the overall model.

The collection of the data for the U.S. model is described in Fair (1976, 1979d), and this discussion will not be repeated here. The data for all the other countries were obtained from the International Financial Statistics (IFS) tape (July 1979) and the Direction of Trade (DOT) tape (July 1979). The following steps were involved in the construction of the data base:

1. A program was written to read the IFS tape and create for each country all the variables in Table 3 except the variables for which DOT data are needed: $\overline{M}_{it}$, $M75\$_{it}$, $\widetilde{PM}_{it}$, $XX\$_{jit}$, $XX75\$_{jit}$, α_{jit} , ψ_{4it} , and ψ_{5it} . Most of the work in constructing the data base was involved in writing this program. No two countries were exactly alike with respect to the availability of the data, and so separate

subroutines were written for each country.[1] The individual treatment of the countries is discussed below. The output from this program was stored by country on a tape called IFS1.

2. A program was written to read the DOT tape and create the $XX\$_{jit}$ data (the bilateral trade data). The output from this program was stored by country on a tape called DOT1.

3. The IFS1 and DOT1 tapes were sorted to store the data by quarter. The sorted tapes were then used together to create the variables: $\overline{M}_{it}$, $M75\$_{it}$, $\widetilde{PM}_{it}$, $XX75\$_{it}$, α_{jit} , ψ_{4it} , and ψ_{5it} . This completed the construction of the data base. For estimation purposes the final data were sorted by country, and for solution purposes they were sorted by quarter.

The individual treatment of the data for each country is outlined in Table A-1. The comments in the table discuss any special treatment of the country. If no comments appear for a particular country, then all the data were available and nothing special needed to be done. Two standard procedures were followed for all the countries, and it is necessary to discuss these before considering the comments in Table A-1. First, if no quarterly National Income Accounts (NIA) data were available, then quarterly data were interpolated from annual data using quarterly data on the industrial production index (IP).[2] If quarterly data on IP were

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[1]Before these subroutines were written, a program was written to print the IFS data in a convenient format. The information needed to write the individual subroutines was taken from this printout. I am indebted to William Parke for help in writing the initial program that read the tape.

[2]The number on the IFS tape for IP is 66.

TABLE A-1. Individual Treatment of the Data per Country

Country	lc	Quar. NIA Data?	Comments
1. United States	U.S. Dollars (mil.)	yes	See Fair (1976, 1979d) for discussion of the U.S. data.
2. Canada	Can. Dollars (mil.)	yes	---
3. Japan	Yen (bil.)	yes	R from 681.
4. Austria	Schillings (bil.)	641 on	Discount rate data for r . R from 701. Made up data for PX and PM for 611-633.
5. Belgium	Bel. Francs (bil.)	no	Made up data for R for 631-633.
6. Denmark	Den. Kroner (bil.)	no	Discount rate data for r . Made up data for R for 774 and 781.
7. France	Fr. Francs (bil.)	no	Interpolated data for IFS71V for 571-614, using IFS73. EMPL used for quarterly interpolations for NIA data.
8. Germany	D. Mark (bil.)	yes	---
9. Italy	Lire (bil.)	most	Discount rate data for r . Quarterly XG data interpolated using quarterly XF data.
10. Netherlands	Guilders (bil.)	no	---
11. Norway	Nor. Kroner (bil.)	no	Discount rate data for r .
12. Sweden	Swe. Kroner (bil.)	no	Discount rate data for r .
13. Switzerland	Swiss Francs (bil.)	no	Discount rate data for r . EMPL used for quarterly interpolations for NIA data. Made up data for PX and PM for 601-604.
14. United Kingdom	U.K. Pounds (mil.)	yes	---
15. Finland	Markkaa (mil.)	no	Discount rate data for r . No R .
16. Greece	Drachmas (bil.)	no	Discount rate data for r . No F . No R . Table A-2 procedure for PM for 571-594.
17. Ireland	Irish Pounds (mil.)	no	Discount rate data for r before 702. No F .
18. Portugal	Escudos (bil.)	no	Discount rate data for r . No F . No PX . Made up data for R for 742-754. Made up data for IP for 743 and 744.
19. Romania	Lei	---	Only e data available from IFS.
20. Spain	Pesetas (bil.)	no	Discount rate data for r . No R .
21. Turkey	Liras (bil.)	---	Discount rate data for r . No F . No R . No IP . PX and PM from 681 on.
22. Yugoslavia	Dinars (bil.)	no	No r . No F . No R . Quarterly PX and PM data interpolated using quarterly CPI data.
23. Australia	Aust. Dollars (mil.)	yes	---
24. New Zealand	N.Z. Dollars (mil.)	no	Discount rate data for r . No F . No IP . NIA year begins April 1.
25. South Africa	Rand (mil.)	most	No F . Quarterly XF data for 611-694 interpolated using quarterly IP data.
26. Algeria	Alg. Dinars (mil.)	---	No r . No F . No R . No IP . No PM . Made up data for IFS70 for 711-713 and for IFS71V for 711-733. PX data from 721.
27. Indonesia	Rupiahs (bil.)	no	No r . No F . No R . No IP . No PM .
28. Iran	Rials (bil.)	no	Discount rate data for r . No F . No R . No IP . No PM . NIA year begins March 21.
29. Iraq	Iraq Dinars (mil.)	no	No r . No F . No R . No IP . No PM .
30. Kuwait	Ku. Dinars (mil.)	no	No r . No F . No R . No IP . No PM . No XF data. Used CPI data for PXF . Table A-1 procedure for other NIA data. NIA year begins April 1.
31. Libya	Lib. Dinars (mil.)	no	No r . No F . No R . No IP . No PM . No XF data. Used CPI data for PXF . Table A-1 procedure for other NIA data.
32. Nigeria	Naira (mil.)	no	Discount rate data for r . No F . No R . No PM . No XF data. Used CPI data for PX . NIA year begins April 1.
33. Saudi Arabia	Riyals (bil.)	no	No r . No F . No R . No IP . No PM . Table A-1 procedure for IFS71V for 571-674 and 721-734. NIA year begins July 1.
34. United Arab Emirates	Dirham (mil.)	---	No r . No F . No R . No IP . No PM . No BOP data.
35. Venezuela	Bolivares (mil.)	no	Discount rate data for r . No F . No R . No PM . No IP .
36. Argentina	Arg. Pesos (bil.)	no	No r . No F . No R . No PM . No PX .
37. Brazil	Cruzerios (bil.)	no	Discount rate data for r. No F . No R . PM from 741 on. Made up data for PM for 782.
38. Chile	Chile Pesos (mil.)	no	Discount rate data for r . No F . No R . PX from 754 on. Made up data for M$ for 671-674.
39. Colombia	Col. Pesos (mil.)	no	Discount rate data for r . No F . No R . No IP .
40. Mexico	Mex. Pesos (bil.)	no	No r . No F . No R . No PM . No PX .
41. Peru	Soles (bil.)	no	Discount rate data for r . No F . No R . No IP . No PM .
42. Egypt	Egy. Pounds (mil.)	no	Discount rate data for r . No F . No R . No IP . No PM . No PX .
43. Israel	Isr. Pounds (mil.)	yes	No r . No F . No R .
44. Jordan	Jor. Dinars (mil.)	no	Discount rate data for r . No F . No R . No XF data. Used CPI data for PXF . Table A-1 procedure for PX and PM data.
45. Lebanon	Leb. Pounds (mil.)	---	Only data on e , MP* , X$, and POP .
46. Syria	Syr. Pounds (mil.)	no	No r . No F . No R . No IP . Table A-1 procedure for PX and PM.
47. Bangladesh	Taka (mil.)	---	No r . No F . No R . No IP . No PX . No PM .
48. Republic of China (Taiwan)	N.T. Dollars (bil.)	no	No F . No R .
49. Hong Kong	H.K. Dollars (bil.)	---	Only e data available from IFS.
50. India	Ind. Rupees (bil.)	no	No F . NIA year begins April 1.
51. Korea	Won (bil.)	yes	Discount rate data for r . No F . No R .
52. Malaysia	Ringgit (mil.)	no	No r . No F . No R .
53. Pakistan	Pak. Rupees (mil.)	no	No F . NIA year begins July 1.
54. Phillippines	Phil. Pesos (mil.)	no	Discount rate data for r . No F . No R .
55. Singapore	Sing. Dollars (mil.)	no	No r . No F . No R . No EX .
56. Thailand	Baht (bil.)	no	Discount rate data for r . No F . No R . No IP .
57. Bulgaria			No IFS data.
58. China Mainland)			No IFS data.
59. Cuba			No IFS data.
60. Czechoslovakia			No IFS data.
61. E. Germany			No IFS data.
62. Hungary			No IFS data.
63. Poland			No IFS data.
64. USSR			No IFS data.

†No estimated equations for this country.

TABLE A-2. Procedure Used to Create Quarterly Data from Annual Data When No Quarterly Interpolation Variables Were Available

Let:

y_t = (observed) average value of the variable for year t ,

y_{it} = (unobserved) average value of the variable for quarter i of year t $(i = 1, 2, 3, 4)$.

Then:

$$\text{(i)} \quad y_{1t} + y_{2t} + y_{3t} + y_{4t} = \lambda y_t \ ,$$

where $\lambda = \begin{cases} 1 \text{ for flow variables (at quarterly rates)} \\ 4 \text{ for stock variables and price variables.} \end{cases}$

Assume that the annual data begin in year 1, and let $\lambda y_1 = a_1$, $\lambda y_2 = a_2$, $\lambda y_3 = a_3$, ... The key assumption is that the four quarterly changes within the year are the same:

$$\text{(ii)} \quad y_{1t} - y_{4t-1} = y_{2t} - y_{1t} = y_{3t} - y_{2t} = y_{4t} - y_{3t} = \begin{cases} \delta_2 & \text{for } t = 1,2 \\ \delta_t & \text{for } t \geq 3 \end{cases}$$

Given (i) and (ii) for $t = 1,2$, one can solve for y_{40} and δ_2 in terms of a_1 and a_2 :

$$y_{40} = \frac{13}{32}a_1 - \frac{5}{32}a_2 \ ,$$

$$\delta_2 = \frac{a_2 - a_1}{16} \ .$$

Using y_{40} and δ_2 , one can then construct quarterly data for years 1 and 2 using (ii). Given y_{42} from these calculations and given (i) and (ii) for $t = 3$, one can solve for δ_3 in terms of a_3 and y_{42} :

$$\delta_3 = \frac{a_3 - 4y_{42}}{10} \ .$$

Using y_{42} and δ_3 , one can then construct quarterly data for year 3. One can then solve for δ_4 in terms of y_{43} and a_4 , and so on.

Note: The annual population data that were collected for the model are mid-year estimates. In order to apply the above procedure to these data, the assumption was first made that each mid-year value is the same as the average value for the year.

TABLE A-3. Construction of the Balance of Payments Data: Data for $D\$_{it}$, $MS\$_{it}$, $S\$_{it}$, and $XS\$_{it}$

Let:

$M\$'_{it}$ = merchandise imports (fob) in \$, Balance of Payments data. [= IFS77ABD.]

$M\$_{it}$ = merchandise imports (fob) in \$. [in Table 3]

$X\$'_{it}$ = merchandise exports (fob) in \$, Balance of Payments data. [= IFS77AAD.]

$X\$_{it}$ = merchandise exports (fob) in \$. [in Table 3]

$MS\$_{it}$ = other goods, services, and income (debit) in \$. Balance of Payments data. [in Table 3]

$XS\$_{it}$ = other goods, services, and income (credit) in \$. Balance of Payments data. [in Table 3]

$PT\$_{it}$ = private unrequited transfer in \$. Balance of Payments data. [= IFS77AED.]

$OT\$_{it}$ = official unrequited transfers in \$. Balance of Payments data. [= IFS77AGD.]

When quarterly data on all the above variables were available, then:

(i) $S\$_{it} = X\$'_{it} + XS\$_{it} - M\$'_{it} - MS\$_{it} + PT\$_{it} + OT\$_{it}$,

(ii) $D\$_{it} = S\$_{it} - X\$_{it} - XS\$_{it} + M\$_{it} + MS\$_{it}$,

where $S\$_{it}$ is total net goods, services, and transfers in \$ (balance of payments on current account) and $D\$_{it}$ is total net transfers in \$.

When only annual data on $M\$'_{it}$ were available, interpolated quarterly data were constructed using $M\$_{it}$. Similarly for $MS\$_{it}$.

When only annual data on $X\$'_{it}$ were available, interpolated quarterly data were constructed using $M\$_{it}$. Similarly for $XS\$_{it}$, $PT\$_{it}$, and $OT\$_{it}$.

When no data on $M\$'_{it}$ were available, then $M\$'_{it}$ were taken to be $\lambda \cdot M\$_{it}$, where (working backward in time) λ is the last observed annual value of $M\$'/M\$$. Similarly for $MS\$_{it}$ (where λ is the last observed annual value of $MS\$/M\$$).

When no data on $X\$'_{it}$ were available, then $X\$'_{it}$ were taken to be $\lambda \cdot X\$_{it}$, where λ is the last observed annual value of $X\$'/X\$$. Similarly for $XS\$_{it}$ (where λ is the last observed annual value of $XS\$/XS$), $PT\$_{it}$ (where λ is the last observed annual value of $PT\$/X\$$), and $OT\$_{it}$ (where λ is the last observed annual value of $OT\$/X\$$).

Equations (i) and (ii) were then used to construct quarterly data for $S\$_{it}$ and $D\$_{it}$.

not available, then the procedure in Table A-2 was used to create the quarterly data. One can thus tell from Table A-1 how the quarterly NIA data were constructed (if they were constructed) by noting whether or not IP data were available.

The second standard procedure concerns the construction of the Balance of Payments (BOP) data, and this procedure is presented in Table A-3. The key variable that is created in this process is $S\$_{it}$, the balance of payments on current account. $S\$_{it}$ is used in the construction of the asset variable, A^*_{it} , for each country. Quarterly BOP data do not generally begin as early as the other data, and the procedure in Table A-3 allows data on $S\$_{it}$ to be constructed as far back as the beginning of the data for merchandise imports and exports ($M\$_{it}$ and $X\$_{it}$). When all data are available, the procedure is a way of linking the BOP and non-BOP data.

Most of the comments in Table A-1 are self explanatory. Data for a variable were "made up" if there were a relatively small gap in an otherwise good series. In these cases the data were usually made up by linearly interpolating between the closest two available observations. In a few cases quarterly data on the consumer price index (CPI) were used for quarterly interpolation of annual data, and for France and Switzerland quarterly data on employment (EMPL) rather than on industrial production were used for the quarterly interpolation of the NIA data.[3] For many countries only discount rate data were available for the short term interest rate (r) , and these cases are mentioned in the table. For a few countries the NIA year began other than January 1, and this had to be taken into account in the quarterly interpolations. These cases

[3] The number on the IFS tape for CPI is 64. For EMPL it is 67.

are also mentioned in the table. For a few countries data on real GNP (XF) were not available, but data on the nominal NIA variables were. In these cases, as indicated in the table, CPI data were used for the GNP deflator. Real GNP was then taken to be nominal GNP divided by the GNP deflator.

Quarterly population data were not available for any country, and the procedure in Table A-2 was used to construct quarterly from annual data. See in particular the note at the bottom of the table.

Quarterly DOT data began only in 1970I, and no attempt was made to construct DOT data before this quarter. Instead, the variables in the model were constructed in such a way (with one exception noted below) that no DOT data were needed in the estimation of the model. In other words, no DOT data were used for the estimates in Table 6. This allowed the estimation periods for most countries to be much longer than would otherwise be the case. The DOT data are needed, of course, for the solution of the model, and so the earliest quarter for which the model can be solved in 1970I. In a few cases annual but not quarterly DOT data were available, and in these case the procedure in Table A-2 was used to construct the quarterly data. In a few cases no DOT data existed, and in these cases the observations were assumed to be zero.

The special treatment of a few countries is discussed in Table A-4. For the oil exporting countries it is clearly unreasonable to assume that the export price index is a good measure of the domestic price level, and so, as noted in point 1 in Table A-4, for these countries the GNP deflator was used in place of the export price index in the relevant equations. All price variables for the oil exporting countries were assumed to be exogenous. For Portugal, Argentina, Chile, Mexico, and

TABLE A-4. Special Treatment of Some Countries

1. For the oil exporting countries (countries 26-35), PXF was used in place of PX in deflating the asset variable for equations 1 and 2. Also, equation 15 was changed for these countries to be:

$$XE_{it} = \psi_{3it}\bar{e}_{it}(X\$_{it}/PX_{it} + XS\$_{it}/PXF_{it}) ,$$

where ψ_{3it} equals the historic ratio of $\bar{e}_{it}(X\$_{it}/PX_{it} + XS\$_{it}/PXF_{it})$ to XE_{it}. PX and PXF are always exogenous for these countries.

2. For Portugal (18), Argentina (36), Chile (38), Mexico (40), and Egypt (42), PX data do not exist, but PXF data do. For these countries PXF was used in place of PX .

3. For countries with no PM data, PM_{it} , M_{it} , and ψ_{4it} were constructed as follows: 1) $M75\$_{it}$ and $\bar{M}_{it}$ were constructed as usual (see Table 3), 2) $M\$_{it}$ was taken to be $\sum_j^1 XX\$_{jit}$, 3) M_{it} was taken to be $\bar{M}_{it}$ (so that $\psi_{4it} = 1$), and 4) PM_{it} was taken to be $\bar{e}_{it}M\$_{it}/M_{it}$.

Egypt, no data on export prices were available, and for each of these countries the GNP deflator was used for the export price index (point 2 in the table). Finally, for a few countries no data on import prices were available, and for these countries the data were constructed as indicated in point 3 in the table. This construction required the existence of DOT data, and this is the exception mentioned above where DOT data were needed for the estimation work. For countries for which DOT data were used in the construction of the import price index, the estimation period had to begin no earlier than 1970I for the equations that relied on these data.

The links to and from the U.S. model are listed in Table A-5. The two key exogenous foreign sector variables in the U.S. model are the real value of exports (EX) and the import price deflator (PIM). When the U.S. model is embedded in the overall model, these two variables become endogenous. The endogenous variables in the U.S. model that affect the rest of the model are the real value of imports (IM), the export price deflator (PEX), the bill rate (RBILL), and real GNP (GNPR). The data base for the U.S. model is different from the data base for the U.S. on the IFS tape (for one thing, the real variables in the U.S. model are in 72\$, whereas the real variables for the U.S. on the IFS tape are in 75\$), and the δ_{it} variables in Table A-5 are used to link the two data sets.

The sample periods that were used for the estimation work are listed in Table 6 in the text. The beginning of the sample period was usually taken to be four quarters after the beginning of the data, and the end of the sample period was usually taken to be the last quarter of the data. One can thus tell from Table 6 approximately how much data

TABLE A-5. Links To and From the U.S. Model

Relevant endogenous variables in the U.S. model (Fair, 1979d):

IM_t = real value of imports (NIA basis), 72\$.

PEX_t = implicit price deflator for exports (NIA basis), 1.0 in 1972.

$RBILL_t$ = three-month treasury bill rate.

$GNPR_t$ = real GNP, 72\$.

Links from the endogenous variables in the U.S. model to the variables that affect the rest of the world:

$$M75\$_{1t} = \frac{IM_t}{\delta_{2t}} - \frac{MS\$_{1t}}{PM_{1t}} = \text{merchandise imports in 75\$, DOT data.}$$

$$M_{1t} = \psi_{41t} M75\$_{1t} = \text{merchandise imports in 75\$, IFS data.}$$

$$PX_{1t} = \frac{PEX_t}{\delta_{3t}} = \text{export price index from the IFS tape.}$$

$$r_{1t} = RBILL_t = \text{three-month interest rate.}$$

$$XF_{1t} = \frac{GNPR_t}{\delta_{5t}} = \text{real GNP in 75\$.}$$

Relevant exogenous variables in the U.S. model:

EX_t = real value of exports (NIA basis), 72\$.

PIM_t = implicit price deflator for imports (NIA basis), 1.0 in 1972.

Links from the variables determined in the rest of the world to the exogenous variables in the U.S. model:

$$EX_t = \delta_{1t} XE_{1t} \, , \quad \text{where} \quad XE_{1t} = \psi_{31t}(X\$_{1t} + XS\$_{1t})/PX_{1t}$$

$$PIM_t = \delta_{4t} PM_{1t} \, .$$

Exogenous variables in the overall model:

$MS\$_{1t}$ (see Table 3)

$XS\$_{1t}$ (see Table 3)

ψ_{31t} (see Table 3) (Note that for the U.S., $\bar{e}_{1t} = 1.0$ for all t .)

ψ_{41t} (see Table 3)

$\delta_{1t} = EX_t/XE_{1t}$

$\delta_{2t} = IM_t/(M75\$_{1t} + MS\$_{1t}/PM_{1t})$

$\delta_{3t} = PEX_t/PX_{1t}$

$\delta_{4t} = PIM_t/PM_{1t}$

$\delta_{5t} = GNPR_t/XF_{1t}$

are available for each country. Some data are available for the countries in Table A-1 for which no equations were estimated, and these data are on the tapes for the model. At a minimum, DOT data are available for these countries.

The tapes that are available for others to use are the following: 1) Copies of the July 1979 IFS and DOT tapes. 2) A tape of the programs that read the IFS and DOT tapes and construct the final data base. 3) A tape of the final data base (including the data base for the U.S. model). 4) A tape of the program that solves the model (including the U.S. model). The last two tapes are sufficient for experimenting with and changing the model. The other tapes are needed only if one is interested in changing the data base. All the programs are written in PLI except the program that solves the U.S. model, which is written in FORTRAN-IV.

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